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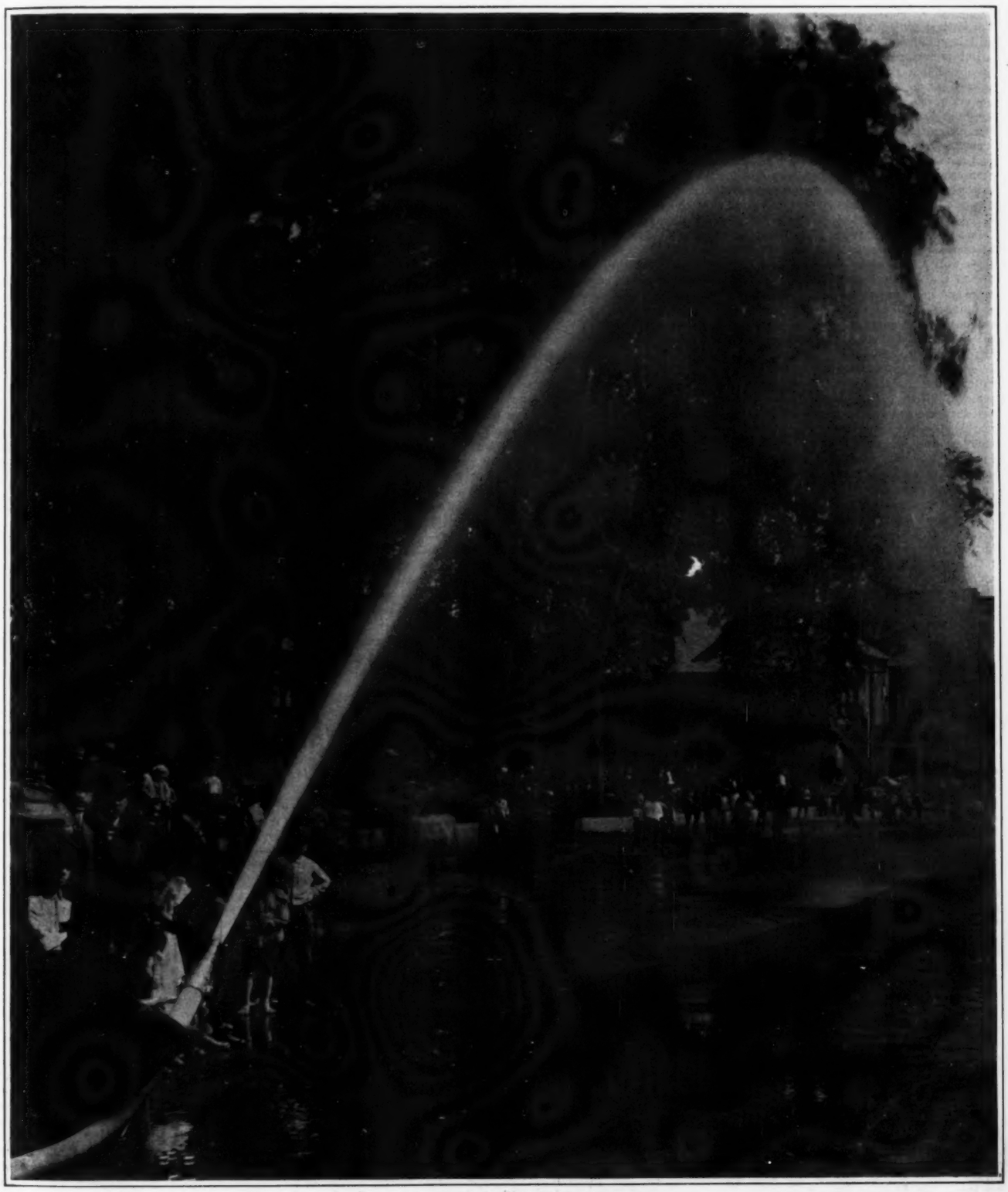

IMPROVED FIRE HOSE NOZZLE THROWING 1¾-INCH STREAM

MODERN DELUGE SETS FOR FIRE EXTINGUISHING SERVICE.—[SEE PAGE 104.]

Gas Power Development: A Review

The Possibilities of an Important Prime Mover

By J. R. Bibbins, M. Am. Soc. M. E.

AT the opening of the present century, many were the prophecies of epochal development in all branches of the technical arts. I believe the decade has fulfilled its promise. First by way of comparison, we find the steam turbine grown from 300 to 30,000 horse-power, with practice both in Europe and America gravitating toward a combinaton of the two principal types. We find single boiler units increased from 300 to 3,000 horse-power; we find the steam engine, then fully developed, now endowed with a new lease of life through association with its erstwhile rival; we find the electric generator literally decimated in bulk but still larger than its turbine.

But returning to the field of gas power; here, too, is measurable progress. In size, engines have developed from the single-acting units of 100 horse-power, or so, to the double-acting tandem units of 4,000 or 5,000 horse-power designed for and operating under the same conditions as steam equipment including the parallel operation of alternating-current generators. We find the steel casting industry, then comparatively undeveloped, now able to turn out intricate one-piece gas-engine cylinders with jackets attached and crank disks with integral pins of the same material. We find producer units developed from a diminutive 10-50 horse-power up to 1,000 horse-power or more, and the problem of bituminous fuels well along toward solution, with practice tending in the direction of the induction type for both large and small units with self-contained vaporizer and continuous service. Opinion is somewhat divided as yet on the tar question, but all efforts are directed toward the abolition of this undesirable by-product by gasifying it.

Industrial Applications.—But in its varied applications, the direct combustion principle has indeed achieved success. It is obviously no exaggeration to say that the gas engine has made possible the submarine, the aeroplane, the motor boat and the automobile. The aeroplane motor offers an object lesson in the results of high rotative speeds. The 30 horse-power motor of the Wright aeroplane weighs but 6 2/3 pounds per horse-power, while the Darracq motor of about the same size, built for the "Demoiselle" monoplane, weighs 3¼ pounds per horse-power. The Gnome engine with radial rotating cylinders weighs still less.

Concerning the much discussed problem of conservation, I need only refer you to the utilization of blast-furnace gas, by-product coke-oven gas, by-product oil gas from refineries and various low-grade or by-product fuels unused for steaming purposes. A large power plant is now being built for using waste cupola gas, which in heat value runs about 50 B. T. U. and requiries 300-pound compression. The importance of these developments in solving the smoke problem and the power problem of our specialized manufactories and in deferring the national crisis—the extinction of fuel supply—cannot be overestimated.

On the one hand, by reason of its high efficiency, the gas-driven pump has found adoption in water-works, sewage disposal, hydraulic excavation and long-distance gas transmission. On the other hand, by reason of the absence of stand-by losses, it is equally desirable in emergency service such as fire protection, auxiliaries with hydro-electric plants and for canal lock operation. The coincident and related development of producers has brought about a revolution in such operations as hardening, tempering, melting, soldering, baking and cloth singeing and especially displacing the supposedly indispensable Bessemer converter with the open-hearth furnace in single units of 400 tons or over.

Gas Engine.—The development of the heavy-duty, double-acting gas engine has been accompanied by certain interesting features which, while not universal, yet find quite wide acceptance in American designs. Foreign center-crank designs have been generally departed from in the use of the side-crank, self-adjustable bearing construction. Experience has been gained with various cylinder materials, all steel or all iron, steel walls only, cast-iron liners, both iron and steel pistons and with steel on steel. The trouble predicted with the last does not seem to have materialized. Krupp builds thin walls with longitudinal reinforcing tension rods while other foreign builders design cast-iron walls as thick as three inches. Dry metallic packing has been substituted for the elaborately water-cooled style. Fads in valve gear have disappeared, and the mechanism has been simplified by driving both inlet and exhaust valves from a single cam.

Cyclic Governing Drop Principle.—In early practice the regulator was quite generally driven from any convenient point along the cam shaft, but now directly from, or at a point close to, the main shaft so as to avoid cyclic torsional effects in the cam shaft. Direct governing has largely been replaced by the relay type using drop cut-off or positive oil pressure to actually move the valves. This has permitted the use of a very small regulator, usually on the German straight line principle, as represented by the Jahns & Hartung design, the weights moving directly against spring pressure. Mixing is now done only at the inlet valves, thus minimizing the result of a back fire. By the symmetrical distribution of gas and air with reference to the four inlets, non-uniform mixing due to unequal fluid-inertia effects has largely been overcome. The electro-magnetic igniter has found much favor by reason of its simplicity, and has made possible ignition at several points in the combustion chamber which has brought more rapid as well as surer combustion with lean gases. A series system of circulation has reduced the water consumption and also the troubles from sweating of cold rods with high sulphur gas. The foreign practice of cambering rods is entirely disregarded here, for with light, one-piece pistons, the rod flexure is not greater than considered desirable to keep the sectional packing free. And finally, centralized, continuous return, lubricating systems are the rule for engine oil, with timed force-feed for cylinder oil. This latter replaces all attempts at graphite lubrication or indiscriminate injection of oil during combustion.

The special adaptation to direct connection to reciprocating compressors has brought about the variable speed, long stroke gas engine (of two diameters or more). These are operated in the natural gas districts of the Central and Western States. One company alone has twenty-four of these units in service, of about 1,300 horse-power each. An interesting feature, brought out by some recent tests by the author, is that for the same power output the gas and heat consumption is not widely different at full or reduced speeds.

A moderate size doubt-acting engine has also come into use with about two-foot stroke whose high rotative speed (200 revolutions per minute) is of great advantage in direct-connected electric drive.

The gas-electric motor car is another interesting development which has been under investigation for several years by railroads for service on extensions or suburban branches where regular steam equipment would not be justified. These cars are self-propelled by a compact eight-cylinder, high-speed generating set located in the cab and standard electric-motor control. Sixty-seat coaches ordinarily make an average schedule speed of 25 miles per hour, including stops. Demonstration runs have resulted in a gasoline consumption of .36 to .48 gallon per car-mile. A single-truck car of this type has been on trial for cross-town service on some of the lines in New York city that have not yet been electrified.

So much for progress and accomplishment. The evidence exists throughout the land from the barking thousands of small engines upon the hillsides of the Pennsylvania oil fields to the great installations at Gary, Buffalo and Pittsburg—in the Mexican highlands a central station burning mesquite, in Texas using lignite, in Canada peat—in the Nevada Ranges a mining plant with Diesel oil engines—in Nova Scotia and Buenos Aires other engines running railroad shops—in Ohio boosting gas to Cleveland—in Arizona watering the Imperial Valley reclamation—in Philadelphia and Coney Island providing high-pressure fire protection—in Pittsburg operating the locks of the Ohio Canalization project. This is admittedly a good record, but we should never be guilty of that smug satisfaction that blinds us to minor shortcomings, so let us glance at some aspects and causes of retarded development.

RETARDATION.

A very serious handicap in industrial work is the present inability of the gas-power system to supply means for factory heating in lieu of exhaust steam. This is particularly serious in the northern states and in Canada. Unfortunately the high efficiency of the gas engine is lost when a "steam eater" is desired in connection with a heating plant. Some progress is being made with the manufacture of exhaust heaters, but the available 5,000 to 6,000 B. T. U. per B. horse-power is not sufficient for heating a large factory. Some system of auxiliary gas-burning heater must be worked out with automatic temperature control to compensate for variations in load. An attempt should be made at conserving this 60 odd per cent waste heat, now rejected in the exhaust so as to return the major part of it to the heat cycle.

The gas engine is roundly scored for not having over-load capacity for fluctuating peak loads. Now with an efficient regenerating heater operating in connection with a low-pressure steam-turbine auxiliary, it is possible to largely increase the output, or vice versa, decrease the fuel consumption. I am glad to report that one of our manufacturers is working along this line on a projected plant.

We must have more convenient and practical methods of measuring power gas both with respect to volume and heating value. No sensible individual would attempt to operate a steam plant without a pressure gage, even neglecting the personal risk, but with gas we are working continuously in the dark and with engines equally as sensitive as steam engines to reduced "potential." Some large plants have, of course, adopted the Venturi meter, but even this simple apparatus is sensitive to deposits in the throat. A continuous recording calorimeter is a great necessity and some progress is being made in that directions.

There is a disposition to discount the demand for large units, both engines and producers. With turbine units increasing by leaps and bounds, the gas-power industry must respond in kind if not in equal measure or remain an "auxiliary" for "special conditions." The 44 × 60-inch cylinder is now in evidence. Let us have higher rotative and piston speeds with relatively shorter stroke and larger diameters if possible. It is to be expected that the production of special high-strength steels and further perfection of foundry practice will make this possible. This improvement in engine construction will remove one of the causes of complaint in the past on large engines—the failure of cylinders and pistons—due for the most part to shrinkage strains.

Nor can it be believed that the producer fuel bed has reached the limit of its diameter, nor the maximum rate of gasification. With a coal combustion of fifteen pounds per square foot per hour an eight-foot producer would yield only 750 B. horse-power. Marine and locomotive practice with induced draft succeeds with many times this rate. A full-grown power plant of to-day requires units of 3,000 to 5,000 kilowatt capacity with at least 2,000 horse-power producers.

Finally, education, not only of operator, but of salesman and manufacturer is needed. The last named is often the least wide awake, and the first the most receptive of intelligent guidance. The great mistake is made in semi-education—first an incomplete understanding of the conditions, second a make-fit equipment, third a jealous guarding of essential knowledge of defects. The result is loss of confidence, dissatisfaction, failure. When will we learn that to take the operator into our full confidence secures his allegiance for all time.

THE FUTURE.

Marine Propulsion.—This most important development looms big on the horizon. Much has been written of the producer-gas system, but it must be confessed that the oil-burning engine is more attractive from the standpoint of convenience and compactness. The advantage of storing oil in the ship's double bottoms is great from a standpoint of cargo capacity. European countries have been active in this development, Russia with its tank ships, France with its submarines, and the coast countries with their fishing fleets. Successful producer-gas equipments are to be found on some of the inland waterways of Europe where coal is the cheaper fuel, and a boat is now being equipped here for service in New York Harbor.

Recently has come the announcement of the adoption of oil engines for the 8,000-ton 12.5-knot freight boats now being built by the Hamburg-American Line. These will be equipped with two 1,500 horse-power Diesel engines built by the Augsburg & Nurnberg Works, and if the experiment is successful, similarly propelled passenger vessels will be constructed. One American builder, at least, has taken up the Diesel engine for marine work.

Power From Crude Oil.—The oil engine development seems to have made great headway abroad since the expiration of the basic Diesel patents. Two of

* Chairman's address before Gas Power Section, American Society of Mechanical Engineers, New York city, December, 1910.

the principal companies have built together 250,000 horse-power with four and six-cylinder units up to 1,000 horse-power capacity per cylinder. Small Diesel engines have been built from five to thirty horse-power. The smaller engines are mostly four-cycle, while above 1,000 horse-power the two-stroke cycle prevails, which in an oil engine works out much more simply than in a gas engine, where separate pumps are required for gas and air. Maximum compression is somewhat over 500 pounds, with air injection at 600 to 850 pounds. In most cases the compressors are built into the main unit and geared. Some of the builders are reported to be developing double-acting designs for engines of high power.

In London one of the electric supply companies has installed Diesel engines, using oil distillate to supplement the transforming equipment of its substations, at a cost per kilowat-hour lower than that for the main stations. A somewhat similar type of plant-operating in one of our eastern cities "boosts" the potential of low points in a direct-current distribution system. The generators, however, are under-compounded so as to limit the output and thus equalize with other parts of the network. Obviously, the oil engine is an ideal prime mover for such service.

In the various experiments with oil-gas producers, the small progress has been discouraging. Two system have been used, the retort and the partial combustion. In the former, difficulties with carbon deposition in the retorts are encountered; in the latter, excessive production of lamp black. Both are hopelessly low in efficiency as compared with the oil-burning steam plants. A large oil-gas plant in California, operating gas engines as water-power auxiliaries, endeavors to apply to power purposes mixed gas, consisting of part retort and part carburetted water gas, utilizing the carbon deposits of the former as briquettes in the latter process. In this mixed gas, the hydrogen content is kept down to about 30 per cent, but in the oil-gas it is very much higher, 40 to 60 per cent. For straight power purposes the combustion producer seems more promising both in simplicity and efficiency. The Imperial Valley project is being served by a small lift station of this type at Yuma, Arizona.

Power in the West.—Closely related is the development of the Western power fields, both for irrigation and for mining operations. The Easterner cannot realize to what extent irrigation has taken hold of the West and what a field there is for power pumping if it can only be developed. Utah, Arizona, Texas and the Great Plains embrace broad areas underlain by basins or hardpan yielding ground waters at a depth varying from a few feet in favored areas to 50 to 75 feet in others. At present electric power pumping is predominant. John C. Hays,* in discussing a California installation, mentions an area of 1,050 square miles, 86 per cent of which is electrically irrigated. He declares, "there is no reason why this field should not be open to gas-power pumping." One installation is already projected with gas-driven generators, but why not direct pumping? No one familiar with the ever-present gas pumpers of the oil fields will fail to see the parallel. But we must have a low-priced engine, simple, fool proof, and preferably of high speed, multi-cylinder type, adapted to direct connection to centrifugal pumps. Present types of high-speed engines are not really adaptable to rotary pumps because of the disparity between impeller proportions and engine speed, although a few sizes can be found suited to low head work. The new Humphrey gas pump is evidently well suited to this service; in fact, some of these pumps are now operating in irrigation enterprises in India. Recently a unit as large as 25,000,000 gallons has been contracted for. This pump utilizes the water column itself as a piston and is approximately "fool proof."

A crude oil engine is obviously a necessity in the Far West. East of the Rockies, lignite suction producers in small sizes would find application; but in California, oil predominates. In 1908 the oil production in California was 48,300,000 barrels, at an average price of $0.54 per barrel. The majority of this was asphaltum base oil, 12 deg. to 17 deg. Be.

In the mining districts we find wood, charcoal and black lignite used for steaming purposes even where water is scarce and impure. One plant, however, accepted the situation and installed Diesel engines with a continuous, closed, fan-cooling system for jacket water.

The development of lignite deposits in the Middle West is encouraging. In 1907 the output west of the Mississippi was 5,000,000 tons, of which Colorado produced one-third, with Wyoming and Texas next in rank, with an average price of $1.55 per ton as compared with $1.12 for all bituminous coal mined in this country. This price does not, of course, apply to the more inaccessible regions, where fuel costs $4 to $8 per ton. Here in the West is an opportunity.

Canada.—We have looked to Canada for important developments in the use of peat, but private experiments have failed so signally that the government has started a peat manufacturing and power plant to demonstrate the process on a commercial scale and re-establish confidence in this industry. Director Haanel of the Canadian Bureau of Mines thus summarizes his investigations: "Artificial drying processes have failed commercially and a machine process must be substituted for the manual labor." The department is therefore proceeding along European lines of established success. He states that Russia alone produced 4,000,000 tons of peat fuel in one year, 1900. Peat containing not over 25 to 30 per cent water has been found an ideal fuel for gas producer work. It requires no further vapor and is quite free from high temperature and clinker. The long series of fuel tests at Montreal have served to confirm the results of our own government's tests on lignites in demonstrating the great possibilities of these lignite deposits, especially in the Canadian Northwest.

Self-Starting Engine.—No real progress is apparent in the self-starting gas engine. Some automobiles are equipped with small compressed air motors, but at considerable expense. No simple combustion method has yet appeared. The opportunity is clear. On very large units, one builder employs for starting an explosive mixture compressed to about 80 pounds and stored in the same manner as the usual compressed air. Some trouble has been experienced in guarding against back-fires into the storage tank.

Double-Deck Stations.—In large cities where land is dear, a new style of power plant would seem to have some possibilities, viz., the double-deck type with the produced plant above. This has some advantages over the familiar double-deck turbine plant in that the steel work of the building would be designed for a dead load, concentrated along the supporting walls where the producers would naturally be located. I am not sure of the comparative costs, but the economy in space in a large plant works out relatively low.

Engineering Economics.—Returning now to a consideration of some of the broader aspects of this subject, it seems to me that there are some fruitful fields still undeveloped. Engineering to-day has become not entirely a technical, but an economic science as well. We must not only ask the question, "Will it work?" but first and foremost, "Will it pay the proper return on the investment?" Consider, for example, the total cost of power production. How much earnest effort has been thrown away in fruitless discussions of mere operating costs, technical finesse, when the language of fixed charges, depreciation, obsolescence, supercession and business risk had not fully been learned. This phase of gas power development has been of serious consequence in the past and undoubtedly responsible for many of the failures on record. Such problems continually arise in the course of comparative studies of gas producer and turbine plants with various load factors and prices of coal. The success of the by-product coke-oven industry in realizing profits from its by-products rests solely upon the economics of the case, and abruptly raises the question, "Which is the major product, gas or coke?" The analysis of the cost of production is of far more importance than that of microscopical improvement in efficiency.

Technical Consular Attaché.—No one can deny the great value of detailed knowledge of the development of the arts in foreign countries. Private individuals or corporations constantly invest large sums in securing such information for their purposes. Now in view of the extended activity of our government along scientific and commercial lines as evidenced by the Geological Survey, the Bureau of Mines, the Bureau of Standards and the Smithsonian Institution, does it seem unreasonable to broaden the usefulness of our consular service by the establishment of a new function, a technical investigating staff whose duties would be to keep constantly before American engineers the more important achievements of foreign contemporaries? The excellent report on "Peat and Lignite" by the Canadian Bureau of Mines is a case in point. The fact is that progress to-day is so rapid that no individual can hope, unaided, to keep abreast without expending time in general investigation that should properly be detailed to special talent. And it seems to me that the national engineering societies should be the leaders in fostering this activity.

Co-operative Research.—The movement toward the co-operation of the engineering fraternities with the educational institutions should be encouraged, first by the more widespread establishment of technical apprenticeships in our shops and offices. It is no exaggeration to assert that to-day the technical graduate furnishes the new blood of industrial enterprise. His training and his ideals form the ground work of a steadily improving standard in commercial life. By the same token, the colleges have a right to expect co-operation. Their costly laboratories are at our disposal for the asking. We spend millions in commercial experiments that can at least only yield approximations. Many of these investigations should be transferred to the laboratory.

There is now before the technical institutions of the country a comprehensive list of subjects needing scientific investigation, many of them of the utmost importance. Could we persuade the manufacturers of the country to endow graduate fellowships in their chosen fields with ample funds for defraying the material costs of such investigations, the return on their investment, I believe, would be well above the "market rate" of interest. A few progressive concerns have taken this step, but they may only be regarded as a precedent. One technical institution has itself provided an endowment.

Interest the student in your business by affording him some incentive and he will become a loyal apprentice, an effective salesman and a competent executive. I beg to suggest that this section take more definite action through the society, along these co-operative lines. As subjects, I need only mention the following as typical. Are there any manufacturers interested?

(a) Maximum efficient rate of combustion in producers as affected by width and depth of fuel bed, rate of blast, moisture content and character of fuel.

(b) Study of chemical reaction in the fuel bed to determine the conditions for suppressing the formation of tar or lamp black and securing maximum percentage of combustibles in gas, together with high overall efficiency.

(c) Study of the relative jacket absorption with varying time contact due to different combustion-chamber and cylinder proportions, and piston speeds.

(d) Effect of auxiliary precompression of charge on efficiency and power of gas engines with reference to securing unlimited overload capacity.

(e) Determination of the most suitable form of gas-engine indicators to standardize accurate methods of working.

(f) Research work on maximum heat values of combustible mixtures, standardizing formulæ for the standard reference cycle.

Work of the Section.—Finally as to the work of the Gas Power Section. The interest manifested in the last few meetings indicates that it has been productive of results. Out of 180 papers presented to the society within the last five years, twenty-four have been devoted to gas power or related subjects, two committees have presented comprehensive reports, and a third committee its detail work from time to time. Although none of the committees now at work have reported conclusively, their preliminary reports have furnished ample basis for further action. Possibly the most pressing need is the standardization of tests and efficiency determinations. These matters were brought to the attention of the society in concrete form by the standardization committee of this section and are now in the hands of the power test committee of the society.

The greatest value, therefore, of the section rests in the contribution to the art in the papers or reports presented. We should not glory in mere numbers, but, on the other hand, excessive concentration in the choice of subjects does not effectively reach the full membership. We may well accept the two contributions on blast-furnace practice as an earnest of our desire for contributions of the highest possible standard. I have heard Lord Bacon quoted on this theme, "I hold every man a debtor to his profession, from the which, as men of course do seek countenance and profit, so ought they of duty endeavor to be a help and ornament thereto." This seems sound doctrine, and in the belief that it will not fall on arid ground, I look for the continued growth of this membership with the very keenest interest.

Although the home of the tin-plate and sheet mills, South Wales is hardly an important center for the manufacture of ordinary steel rolled sections, or of pig iron, it is now stated that two new steel works at Barry, in South Wales, are in contemplation, as well as another at Irlam on the Ship Canal. According to published statements, the larger of the two Barry schemes will be very complete, and will embrace blast furnaces and steel works for the production of sheets and heavy rolled sections. The other works is expected to specialize in heavy rolled sections. The Irlam works, like the Barry schemes, will depend largely upon imported raw materials, anyway upon water-borne materials, except as regards fuel. Middlesbrough and the Clyde districts cannot be expected to welcome these new additions to the steel industry. It is to be noted that other recent additions to British iron and steel industries have shown a disposition to situate themselves in other districts, more especially Lincolnshire and South Yorkshire.

* American Institute Electrical Engineers, May, 1910, The Mount Whitney Power Co.

Correspondence.

The Improvement of the Flying Machine

To the Editor of SCIENTIFIC AMERICAN SUPPLEMENT:

Recent events in the science of aerodynamical flight have followed preceding flying feats with so marked an advance that to the layman it would appear that the true subjugation of the air is accomplished beyond dispute. Yet to the impartial student of natural and artificial flight it cannot honestly be conceded that progress with mechanical flying machines has justified the belief that it is commensurate with the vast number built and experimented upon. Indeed, the skill of the pilot has progressed more than the improvement and evolution of the machines. It is the object of this article to consider precisely the question of both natural and artificial locomotion in the air, and to analyze recent experiments on the one hand with their obvious faults, and on the other demonstrate those superior qualities enjoyed by Nature's machines whereby they excel man in the real conquest of atmospherical space. From the analysis it will be shown that there are neither subtle mysterious laws nor inscrutable mechanics in nature as exemplified in the volant bird, bat, or insect that cannot be faithfully reproduced by the methods and intelligence of man, and that in comparison with the feats of the bird he not only accomplishes them but actually surpasses them.

Without describing exhaustively the structure and the infinite number of designs discovered in the animal kingdom, it may be remarked that the earliest known flyer is the extinct pre-historic pterodactyle (*Pterosauria*): wing-fingered specimens having been found in their fossilized form in the cretaceous rocks of America and England with membraneous wings 25 feet span. In striking contrast is the tiny *Diptera* or "two-winged" with microscopic-sized rudimentary posterior wings or "halteres" which act as balances in flight, seen in the house-fly, wasp and bee. To this order should be added *Coleoptera*, comprising the beetles, *Hymenoptera*, butterflies and moths, *Adonata*, the wonderful dragon-fly, *Cheiroptera*, the bats, and

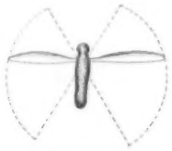

Fig. 1.—The Insect's Wing Traveling in Horizontal or Waved Figures-of-8 Line of Progression Shown by Dotted Lines

lastly the countless designs observed in the perfection of flight, the true aeroplane, the bird. Varied in structure and contour though all may be, it is significant that *all* fly on one and the same principle—or possess the power to accomplish it—that of the screw. Innumerable in variety, some being falcated or scythe-like, others oblong or rectangular, others rounded or circular, while others again being lanceolate or linear, the fact remains that, whereas the *designs* need not be restricted in number, the main principles and agencies underlying the same must not be departed from if the conquest of the whirls and eddies of air is sought. Note therefore that there must be neither divergence nor departure from natural laws. *A thorough knowledge alone will enable us to design fundamentally and construct a true flying aeroplane.*

Hence without unduly enlarging on structural points in nature, we know as demonstrated by Pettigrew's life work that the wings of birds, bats, and certain insects are of helicoidal curvature with a certain concavo-convexity of form near the shoulder, while all are semi-rigid anteriorly and flexible posteriorly and toward the tips, also graduating in thickness from the root and tapering to a fine plastic point at the tips, which enable the pinions to be automatically stable when encountering opposing winds or those of a vertical tendency, and consequently conferring those fine qualities which react upon the air with such efficacy in obtaining the maximum of horizontal displacement or support while securing a minimum of resistance in flight. They form both structurally and functionally reversing screw propellers, one primary feather in fact being equivalent physiologically and morphologically to one whole wing.

It is, however, the following points that the writer wishes to enhance, as they constitute the key to the whole problem of success and are the true dogma and distinguishing feature whereby the subjugation of the air *must* be accomplished. Wings, besides being structurally and functionally powerful propellers, sustainers and elevators of remarkable efficacy when beaten in helicopteral flight in forward translation, have their "sail area" of apparent inefficient dimensions, and one would imagine, wholly incapable traveling surfaces. Quite so. Yet Nature, foreseeing that in order that her children should subdue and not be subdued, increases the "sail area" by bewildering rapid motions or beats, thus augmenting the dimensions and creating *solid bases of support* by superior speed, perfected traveling surfaces designed to satisfy the resiliency of the air and the inertia of the mass of the flying animal, and superior power residing in the powerful pectoral thoracic muscles. Slight though these may be in comparison to the enormous weights and motors of man, there is no gainsaying the fact that natural machines soar in winds and accomplish feats we have hitherto failed in, thus furnishing a practical demonstration that the *whole "wing-area" is utilized* to con-

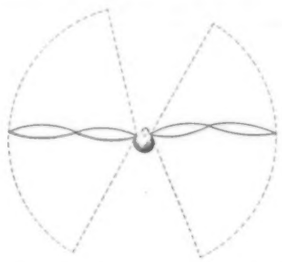

Fig. 2.—The Effective Sustaining Area Due to the Sweep of a Bird's Wings

summate the triple function of propelling, sustaining and elevating the flying creature. Figs. 1, 2 and 3 illustrate this principle concisely, the first showing the insect's wing traveling in a horizontal path or a waved figure-of-8 line of progression, as shown by the dotted lines; the second representing the bird; the last illustrating the screw-propeller of man reproducing precisely similar principles and results in rotation in a circular path against the reciprocal motion of the bird and the insect. Here then is the first simple triumph and improvement mechanically furnished by Man over Nature, i. e., the transference of reciprocating into rotary motion.

Accepting the bird as the ideal aeroplane model we find that steering at right angles and horizontal movements present little difficulty and are accomplished in a variety of ways. A bird flying diagonally through the air attains its maximum of support or pressure at the front edge of the wings, increase of velocity tending to thrust up the anterial margin, the bird counteracting this by accommodating its center of gravity farther forward, backward, or raising and lowering the same in accordance to conditions. This is secured by (1) raising the wings in a dihedral angle above the body, resulting in lowering the center of gravity; (2) flexure of wings against the body, thus bringing the same farther forward; (3) throwing conversely the wings forward and so correspondingly reversing the conditions, or by (4) extending the head and neck as in the case of the pelican, stork, or flamingo, and spreading the tail. Steering is effected either by (1) raising one while depressing the other; (2) diminution of the parachute area of either wing; (3) twisting the pinions into an helicoidal curvature, which principle is that copied by the Wrights and confiscated by all other aeroplanists, (4) or by raising and lowering each side of the tail. Compare the varieties of movements and capabilities with the superior qualities of flexible construction of wings and latent power to beat them, against the inert, immobile and passive "sail area" of the aeroplane, which can readily be detected. In Fig. 4

Fig. 3.—Screw Propeller; the Dotted Line Gives Projected Area

is shown in section an ordinary Blériot type monoplane of some 30 feet span with the usual 6 feet 6 inches tractor in the center. The insufficient active surface of the same is portrayed by the dotted lines clearly demonstrating the poor comparison of active *versus* passive "sail area," the latter predominating in excess as against Nature's examples where the *whole area is utilized*. If, however, the aeroplane surfaces are constructed with flexible tips and posterior margins and twin screws are employed of twice the diameter of propellers, it will immediately be recognized that these superior qualities seen in the bird are greatly enhanced, and ability to fly in stronger winds is attained by simple means. As an illustration of the inability of the modern aeroplane lacking adequate means of conquering adventitious currents, the writer quotes from the report of the Blackpool aviation meeting in England, from an aeronautical contemporary: Owing to the strong winds varying in velocities, no aeroplanes ventured out from their sheds even, and the only aviators seen aloft were the sea-gulls, and *they* flew all day long.

Thus the incontestable fact remains that although certain aviators like Latham, Paulhan or Johnstone have flown by superior skill in winds which others dread, it is for a brief period only, while the slight power residing in the muscles of the gulls compared with the 50 to 120 horse-power and great increase in the mass of machines weighing from 600 pounds to nearly a ton, sufficed to enable the bird to beat man's efforts at subjugating the air by simply adopting well defined proven laws instead of copying others' faults as man is content at present to do!

From the foregoing remarks, which are briefly subtracted and amplified from the lecture given by the writer, entitled "Fying Ships of the Future," in 1908 at the Royal United Service Institution, Whitehall, England, it will be conceded without prejudice that a remarkable co-relation exists in the laws of nature and the improved flying machine built by man. Indeed, in order to prevent repetitions of fatal accidents with the modern *incomplete* aeroplane, the cause is not far to seek as the foregoing lines demonstrate, in the remedy presented. The world is asking for enlightenment in this respect, but how correct are the explanations? Certainly not by constructing the traveling surfaces of the aeroplane wings more rigid, heavy and inert. No. Flight by mechanics is the product of superior inertia, volition, power, and *properly constructed* traveling organs or wings, and there can be no question that under such conditions, machines embodying these requirements will afford a veritable example of *multum in parvo* and will make flights around the world, over sea and land, perfectly feasible. Given adequately powerful reliable engines, improved traveling surfaces, either rotary or reciprocal, and *whose active area predominates*, whereby is elicited a responsive upward and forward recoil on the air instead of inert, passive surfaces seen in the present aeroplane,

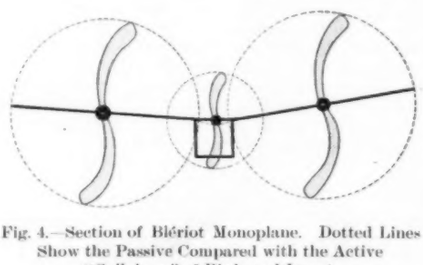

Fig. 4.—Section of Blériot Monoplane. Dotted Lines Show the Passive Compared with the Active "Sail Area" of Birds and Insects

the perfected yet simple airships with these essential features will literally forge itself with the potential aid of gravitational energy and the immense inertia of the dynamic mass through all resistances of wind tending to deflect it from its path, thus ensuring the *true subjugation of the air*.

Pimlico, London. EDGAR E. WILSON.

Guns in Mine-laying Vessels

THE question of providing suitable gun arrangements for mine-laying vessels is, it is reported, engaging the serious consideration of the British Admiralty. This valuable type of auxiliary vessel has, as the result of the trials and experiments carried out since its inception, developed into a single independent unit. Being self-contained, and therefore ready at all times to act on her own initiative, she can select the most suitable time as regards weather conditions, and also take the best route to proceed as rapidly as possible in order to achieve her object, namely, the blocking of a possible enemy's port. This line of development has of necessity taken her farther and farther from the original conception of her duties, which was to act as one of a group of similar vessels under the protection of an escort of cruiser or battle units. This change has rendered the question of her protection against possible attack when moving to and from the danger zone one of vital importance. In the case of the "Intrepid," recently converted for use as a mine-layer, it has been decided to provide her with an armament of 6-pounder quick-firing guns. This is, however, felt to be only a tentative measure, as these excellent little guns are now quite outclassed by the improved armament of 4-inch and 12-pounder, or their equivalent in foreign navies, which are now mounted on modern destroyers. In circles competent to judge it is considered that a small mixed armament of 4.7 inch—of which there are a large number in reserve—and 12-pounder quick-firers would be an ideal armament for this class of vessel, or at least nothing smaller than 12-pounder guns should be included.

The Gas Turbine*

A Consideration of Proposed Types

By A. W. H. Griepe

IT is generally recognized that one of the chief difficulties in the way of devising a practical gas turbine is to find a material for the vanes which will be capable of withstanding the effect of being in contact with gases at the high temperatures produced by combustion.

Properties of Gasoline and Air.

Test Number.	Mixture Volume.		Time, in Seconds, Between Zero and Highest Pressure.	Explosive Force, in Pounds, per Square Inch.			Temperature of Combustion, in Deg. Fah.	
				Compression of Air, in Pounds, per Square Inch.				
	Gasoline Vapor.	Air.		42	57	71	Actual.	Theoretical.
1	1	13	0.28	156	208	260	1857	3545
2	1	11	0.18	183	244	305	2196	4010
3	1	9	0.13	234	312	390	2803	4806
4	1	7	0.07	261	348	435	3119	6001
5	1	5	0.05	270	360	450	3226	6854
6	1	4	0.07	240	320	400	2965	5517

* At atmospheric pressure.

The actual temperature of the gases, however, though high, does not approach the theoretical temperature, as is shown in the table, the figures of which they obtained in laboratory tests made by Dr. Richard Wegner, of Heidelberg, Germany.

Forcing steam or water into the rotor to cool the blades has been suggested as a means of preventing their destruction by the high-temperature gases. This arrangement, to be effective, would no doubt complicate the construction of the turbine considerably, and would probably reduce its efficiency.

An excess of air in the mixture has also been suggested as a means to this end. The effect on the explosive force of the mixture is clearly shown in the table. Several attempts have been made to use blades made of heat-resisting materials, such as quartz and slate, etc. Hard porcelain reinforced by wire mesh has also been tried, but with very little success.

Blades made of vanadium steel and covered with a layer of magnesia have shown the best results so far, but have not proved sufficiently good to warrant the use of this combination.

Fig. 1 represents diagrammatically a gas turbine of the velocity-stage type coupled to a three-stage centrifugal air compressor, as proposed by Dr. Stolzet, of Charlottenburg, and described in a paper read several years ago. The gas, which is controlled by the flyball governor, enters the explosion chamber under pressure and is mixed there with air (under pressure from a three-stage centrifugal air compressor). The mixture is fired in the chamber, after which the air and hot gases, expanding in the nozzle, enter the turbine, where they give up their energy in much the same manner that steam does in the steam turbine, passing the rotating and stationary blades on their way to the exhaust outlet.

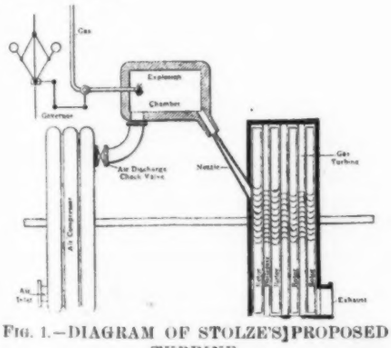

FIG. 1.—DIAGRAM OF STOLZE'S PROPOSED TURBINE

An improvement has been proposed for this type of turbine unit which consists in forcing steam or water into the combustion or explosion chamber in order to reduce the temperature of the burning gases to a temperature that will be safe for the vanes.

Fig. 2 is a more or less diagrammatic sketch showing an elevation and cross-section through a reaction type of turbine proposed by Dr. Wegner and described in a paper written two years ago.

* From *Power and the Engineer*.

† This arrangement is attributed to Rudolf Barklow by Mr. Suplee in his book "The Gas Turbine."

The turbine rotor is made up of four tubes, closed at the outer ends and flanked on each side by round plates, as indicated. These plates are provided with circular openings which admit air for cooling the tubes after each explosion. (See the elevation.) The tubes and plates revolve on a shaft in the direction indicated by the arrow.

At the outer end each tube is a De Laval nozzle, and near the center of the hub are two openings, axially opposite each other, for use in the admission of gas and air, both openings being guarded by check valves. The gas check valve, as will be noted, is connected to a ring which passes in front of a segment with a circular opening which admits the gas.

A spark plug is attached near the outer end of each tube, as shown in both views.

When passing by the gas-admission segment, each tube is filled with gas and air through the check-valve ports. The gas is under a higher pressure than the air, and therefore forces the air check valve to its seat, and as the turbine revolves further the centrifugal force compresses the mixture in the outer ends of the tubes. The spark plugs then ignite the mixture, after which the hot gases, escaping under pressure through the De Laval nozzles, force the turbine to revolve in the direction opposite to the outflow of the gases.

After the explosion occurs the check valves open again, admitting cool air which clears the tube of the burnt gases, at the same time cooling the tubes. As

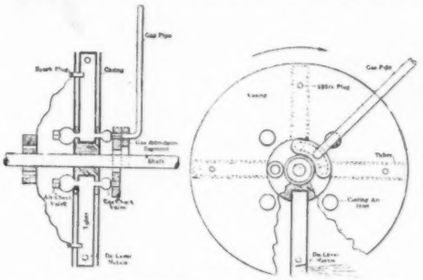

FIG. 2.—DIAGRAMMATIC SKETCH OF THE WEGNER PROPOSED GAS TURBINE.

the casing and tubes revolve, air is sucked in through the cooling air inlets (shown in the elevation) which further facilitates the cooling of the tubes after each explosion.

Four explosions occur for each revolution of the turbine, and the reaction of the outflowing gases against the atmosphere is the source of the power.

The turbine is therefore a reaction turbine in its simplest form, making separate air compression unnecessary.

THE GRIEPE TURBINE.

Figs. 3 and 4 show a gas turbine designed by the writer, which is really a combination of the gas engine and gas turbine. The unit consists of the turbine, a three-stage centrifugal air compressor, an air accumulator and a gas chamber. The whole unit is set on a common base, which is built out as an exhaust chamber.

As will be noted from the following description, the flow of hot gases against the blades is intermittent,

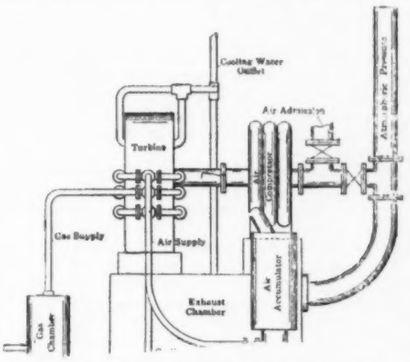

FIG. 3.—COMPLETE ARRANGEMENT OF GRIEPE'S PROPOSED GAS TURBINE UNIT

which gives the blades time to cool somewhat between the moments when they are in contact with the gases.

The rotor *A* (Fig. 4), which is shown in black, is made up of a series of expansion chambers containing blades *B* and a series of closed compartments *C*, which separate the expansion chambers. The rotor *A* carries a ring *D* having openings *E* to admit gas from the gas chambers to the explosion or combustion chambers *F*.

Contact pieces *G*, fastened to the rotor, close the electric circuits of the spark plugs, which are located in the walls of the explosion chambers. Explosion chambers are provided on both sides of the rotor web, but are staggered angularly to avoid dead positions.

The main structure contains compartments for compressed air, cooling water, and gas, as shown.

The explosion chambers *F* are located on the outer part of the central structure, and are alternately closed and opened to the expansion chambers by the inner faces of the compartments *C*. The explosion chambers may be as shown, or carried completely around the circumference of the central structure, according to the size and power of the turbine.

Compressed air from the compressor passes through the four-way valves *K*, which act as injectors. The air draws a certain quantity of gas along with it while passing through the valves, and the mixture is forced

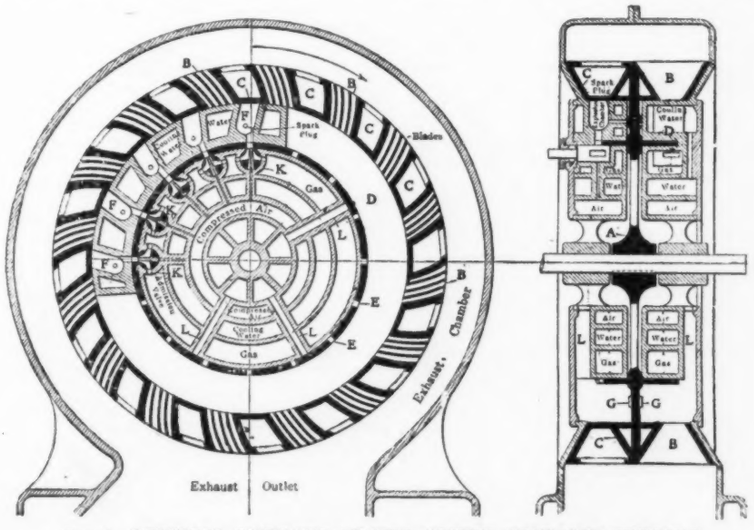

FIG. 4.—VERTICAL SECTIONS OF THE GRIEPE PROPOSED TURBINE

into the combustion chambers whenever the admission openings *E* in the rotor ring *D* register with the channels to the combustion chambers. After these openings have passed, closing the channel again, the revolving contacts *G* close the spark plug circuits and the mixture is exploded. During this part of the revolution of the rotor, the blade compartments are nearly

opposite the explosion chambers, and an instant later they register and the gases escape through the vanes, forcing the rotor in the direction of the arrow. Further motion of the rotor brings the compartment C again over the openings of the combustion chambers, and the cycle is repeated.

In the design shown here it is evident that the vanes or blades *B* are not continuously in contact with the high-temperature gases, as during three-quarters of a revolution of the rotor the blades are surrounded by gases at a lower temperature cooled by air admitted through the air channels *L* into exhaust chamber.

The centrifugal air compressor driven by the turbine discharges into an accumulator to insure uniform air pressure. The density of the explosive mixture of gas and air can be regulated by adjusting the air pressure.

A further change in the output of the turbine can be attained by opening or closing one or more of the four-way valves *K*, thus changing the number of explosion chambers in action.

Production of Low Temperature and Refrigeration—I*

The First International Congress of Refrigerative Industries

By L. Marchis

THE first International Congress of Refrigerative Industries, held at Paris October 5th-12th, 1908, was remarkable for the number and importance of the papers submitted by the men of science and engineers who responded to the call of the organization committee.

The congress was divided into six sections as follows:

First section. Low temperatures and their general effects.

Second section. Refrigerating media.

Third and fourth sections. Application of refrigeration to food and in various other industries.

Fifth section. Application of refrigeration in commerce and transportation.

Sixth section. Legislation.

In this article we do not intend to summarize the memoirs and communications presented, but rather to give a general view of the congress that brought together men of science, engineers, biologists, legislators, and men from the business world.

I. LIQUID AIR AND THE PROPERTIES OF BODIES AT LOW TEMPERATURES.

The first section considered principally the production of liquid air and the preparation, with this as a starting point, of oxygen and nitrogen in a commercial way.

It is well known that air, like all gases, is brought into a liquid condition by the combined effect of lowering its temperature and expanding it sufficiently. In carrying out this process, gaseous air cooled to a low temperature is expanded suddenly from a pressure p_0 to a lower pressure p_1. Part of it goes over into a liquid state, and the other part, gaseous and very cold, is led into an economizer, where it cools down the air that is being compressed to the pressure p_0 for the first time.

The essentially adiabatic expansion of air can be effected in two different ways.

(*a*) Air compressed to the pressure p_0 may be expanded without doing available exterior work. It passes from the compression tank to the liquefaction tank by the way of a narrow orifice. This is the manner of expansion adopted by Linde in his liquid-air machines. The lowering of temperature obtained under such conditions is only appreciable if the difference between the pressures p_0 and p_1 is considerable. In Linde's apparatus† gaseous air cooled to about —100 deg. C. is expanded from a pressure of 200 to 40 atmospheres; the liquefied part of the gas at about —140 deg. C. passes into a regenerator where it cools the air compressed at 200 atmospheres; it is then led into a pump which brings it up to this latter pressure. A second auxiliary pump draws air from the atmosphere to take the place of that part which has been liquefied. In the industrial machines the gases compressed to 200 atmospheres, before passing into the economizer where the gas at —140 deg. C. circulates, are cooled by liquid ammonia.

Under such conditions, in machines which produce 50 liters per hour the yield of liquid air is about half a liter per horse-power hour.

(*b*) The second method of air expansion consists in utilizing the exterior work which the gas is capable of doing when it passes from pressure p_0 to p_1. This mode of expansion with utilizable exterior work is the basis of the processes of G. Claude for the production of liquid air.‡ Air compressed to a maximum pressure of 30 or 40 atmospheres passes first to an economizer, where it is cooled down as in Linde's apparatus by unliquefied gas. It is then expanded in the cylinder of a motor whose energy can be utilized in the original compression of the air. In course of time a partial liquefaction of the air occurs in the cylinder of the auxiliary motor. The lubrication of this cylinder is accomplished by means of a petroleum distillate having a specific gravity of 0.675 (automobile gasoline), which, at the low temperature at which the motor operates, attains a sirupy consistency comparable to industrial lubricants.

Applied in this form the process of G. Claude gives only unsatisfactory results. The expansion of the air, occurring at temperatures of —175 deg. to —180 deg. by the gas expanding in the auxiliary motor, takes place under unfavorable conditions. The appearance of liquid air in this auxiliary cylinder is likely to produce a peculiar water-hammer effect and is accompanied by a large increase in friction, that is to say, by a correlative destruction of the liquid air produced. Moreover, under the most favorable conditions the yield of this machine is hardly more than 0.2 liter of liquid air per horse-power hour.

For this reason M. Claude has been led to modify the process in the following way, which I shall endeavor to explain: A part of the cooled current of air compressed to 40 atmospheres is deflected before it arrives at the expansion cylinder. This air under a pressure of 40 atmospheres is led into a chamber (liquefier) cooled by the gas of the original current which has been expanded in the auxiliary motor. Thanks to a pressure of 40 atmospheres the deflected gas is liquefied in this latter chamber at a temperature no longer of —190 deg. C., as was the case in the original process, where liquefaction occurred at the limit of its expansion, but at —140 deg. C. Furthermore, the expanded air which circulated in the liquefier is heated up and arrives in the economizer no longer at —190 deg. C., but at about —130 deg. C. It cools the gas in the feed conduit less, so that this gas arrives in the auxiliary motor at a temperature of about —100 deg C. Its expansion takes place, therefore, under more favorable conditions, and liquefaction by expansion is less to be feared.

By thus substituting liquefaction under pressure for spontaneous liquefaction by expansion, M. Claude had brought his process of recovering the energy of expansion down to a practical basis. With machines utilizing an exterior air compression capacity of 75 horse-power the yield of this process becomes as high as 0.7 liter of liquid air per horse-power hour.

This idea can be carried still further, however. The air which arrives at the auxiliary motor at a pressure of 40 atmospheres and a temperature of about —100 deg. C. can be subjected in expansion to a too great drop in temperature. To avoid the recurrence here of the difficulties encountered in the original process all that has to be done is to carry out the expansion by degrees in several auxiliary cylinders. The air of the first expansion can circulate about a first liquefier, into which is led a deflected portion of air from the feed circuit in a cold and compressed condition. The circulating air is warmed up and goes on to be expanded in a second auxiliary cylinder. This air from the second expansion is sent into a second liquefier similar to the first, and is finally led into the economizer. In practice the two liquefiers are not distinct; the two currents of air after expansion merely circulate about different sections of the same liquefaction apparatus. M. Claude has given the name of "compound liquefaction" to this last process. It marks a new and important step in the technique of the liquefaction of air. In machines of the type described above the yield of liquid air, by the application of compound liquefaction, is as high as 0.85 liter per horse-power hour.

Liquid air promises to be the sole industrial source of oxygen and nitrogen. The manufacture of these two gases at a very low price is a problem the solution of which has a very great importance in metallurgy and in the fertilizing industry. How we can derive these gases from liquid air is a problem that I am now going to consider.

Oxygen and nitrogen are two bodies whose critical points are slightly different (—118 deg. C. and 13 atmospheres for oxygen; —146 deg. C. and 33 atmospheres for nitrogen). The vapor tension curve of nitrogen is below that of oxygen. At a like temperature, below the lower of their critical temperatures, the two gases, considered separately, liquefy at very different pressures. The liquefaction of air—that is to say, a mixture of these two gases—presents, however, some peculiarities which are worth mentioning.

If at a sufficiently low constant temperature, T, air is compressed in a closed chamber, the following phenomena may be observed:

(1) At a predetermined point of pressure, P_0, a first drop of liquid appears. This is what, after Duhem,* we call the dew-point.

(2) If at the constant temperature T the volume of the air is diminished the pressure increases; at the same time the quantity of the liquid phase grows larger. If this increase of the pressure is continued all the air will pass into the liquid state, the values for P, and T for pressure and temperature at that instant, characterizing what Duhem has denoted the boiling point.

(3) The dew and boiling points obtained at different temperatures trace in the system P O T, on one hand the dew line and on the other the line of boiling of the gaseous mixture considered.

(4) For each system of values (T, P) of temperature and pressure the two phases, liquid and gas, are in a state of equilibrium; in this state the composition of the two phases is different.

(5) The percentage of oxygen (the more easily liquefied element) in either liquid or gaseous phase, we will term the content of this phase.

The content of the liquid phase in a sate of equilibrium is always greater than the content of the gaseous phase. At a constant temperature, when the pressure is increased, the contents of the two phases, liquid and gaseous, continue to diminish till the mixture is completely liquefied. Thus, when air is liquefied (volumetric content 21 per cent oxygen) the first drop of liquid contains oxygen and nitrogen and its content is 47 per cent. This content continues to diminish as the volume of the liquid phase increases. A liquid with 34 per cent oxygen can only be in equilibrium with gas of 12.5 per cent oxygen. But as long as there is a gas phase its content is considerably above zero C. It remains above 7 per cent.

It can be readily seen, therefore, that if the two phases, liquid and gaseous, formed by the progressive liquefaction of air are maintained in contact, it is impossible to prepare gaseous nitrogen of a sufficient degree of purity.

It is a different matter, however, when, under constant pressure conditions, the liquid phase is eliminated as fast as it is produced. We find ourselves here in the presence of a phenomenon inverse to that observed when liquid air is distilled under constant pressure. In such a case the contents of gaseous and liquid phases increase continuously. The phases both tend toward a composition of pure oxygen. At the same time the temperature of boiling rises from a value in the neighborhood of that of pure nitrogen to the boiling point of pure oxygen. Inversely, if we progressively condense air under constant pressure, eliminating the liquid phase as fast as it is formed, there are obtained gaseous residues less and less rich in oxygen; at the same time the temperature of condensation becomes lower and tends toward the boiling point of pure nitrogen at the pressure employed. We obtain, therefore, much more rapidly than in the process considered above a gaseous mixture richer in nitrogen. To obtain a gaseous residue practically free from oxygen, however, it is necessary, if this method is used, to almost completely liquefy the air.

A much better result is obtained by the use of a device designed by M. Claude which he calls a retour en arrière (reflux apparatus).

Let us imagine that the liquid after separating from the gas encounters a gaseous mass richer in oxygen. The liquid is colder on account of the large proportion of nitrogen it contains. A part of the more condensable oxygen of the mixture will therefore be liquefied and take the place of nitrogen which will vaporize. Thus by circulating in opposite directions a liquid and a gas having different contents, there is obtained on one hand a liquid very rich in oxygen and on the other practically pure gaseous nitrogen. This process utilizes, moreover, a large amount of air which never needs to be liquefied.

* Translated for the Smithsonian Institution's Annual Report from the Revue générale des Sciences pures et appliquées, Paris, twentieth year, No. 5, March 15th, 1909.

† For a description of Linde's machine, see E. Mathias "La préparation industrielle et les principales applications des gaz liquéfiés." *Revue générale des Sciences*, vol. xii., 1901.

‡ Readers desirous of obtaining the details of Claude's processes will find an account of them in the following: G. Claude: Air liquide, Oxygen, Azote. Paris, H. Dunod and E. Pinat, 1909.

* Duhem: Traité de Mecanique chimique, vol. iv, Chap. 3. Paris, Herman.

M. Claude has utilized this principle of reflux in the following way: A sort of small tubular boiler is arranged so that its axis is vertical. The tubes are surrounded on the outside with liquid air, and into the lower ends of these tubes is led a current of cold compressed air. This liquefies progressively, giving liquids poorer and poorer in oxygen; these liquids, in falling into a receptacle below, encounter gases rich in oxygen and produce the gradual dilution, the principle of which we have described. There finally separates out at the top of the group of tubes practically pure nitrogen, while liquid with a high per centage of oxygen is continually drawn out of the lower part.

A second obstacle remains still to be overcome. Instead of air supercharged with a volumetric content of 47 per cent oxygen, it is necessary to obtain practically pure oxygen. This can be attained, thanks to processes of rectification based on those employed in the alcohol industry. In such a process there are two circulating streams inside of a column, one from the bottom to the top, of practically pure oxygen gas, and the other from the top to the bottom, of liquid containing a large proportion of nitrogen. The latter, being colder, condenses the oxygen and allows its nitrogen to escape in a gaseous form according to the process which we have seen developed in connection with the reflux apparatus.

The apparatus for this purpose is again composed of a sort of tubular boiler with its axis vertical. At the upper end it continues into a column with condensing shelves, such as is used in the alcohol industry. The vertical tubes of the boiler are surrounded by practically pure oxygen, and into the interior of these tubes cold air is introduced at a pressure of about five atmospheres. As previously explained, this air becomes liquefied, giving in the lower part of the boiler liquid air surcharged with oxygen and in the upper part practically pure gaseous nitrogen. This is carried through the liquefied oxygen and in turn becomes liquefied. The superoxygenated liquid is carried up (through a tube) by its vapor pressure and flows continuously into the central part of the rectification column. The liquid nitrogen is conveyed to the summit of the column. The oxygen vaporized in the tubular chamber on account of the condensation of the air in the interior of the tubes, encounters, in the rectifying column, liquids richer and richer in nitrogen; there falls back in the still, consequently, liquid oxygen in a practically pure state, while pure nitrogen separates out at the top of the column. The quantity of liquid oxygen which falls back into the still is greater than the amount which vaporizes and ascends into the rectifying column. This excess of oxygen is drawn off and led by way of an economizer to meters and to apparatus where it is used.

Such is the principle of the Claude method for the production of practically pure oxygen and nitrogen. The Linde method differs only in certain of its details. The Bardot factory, which works the Linde process at Aubervilliers, at present produces about 50 cubic meters of oxygen per hour. The Société de l'Air Liquide, which uses the Claude process, has placed in operation apparatus capable of producing 100 cubic meters of oxygen per hour. The yield is about one cubic meter of pure oxygen per each horse-power effective on the shaft of the compressor, in apparatus of 50 cubic meters, and about 1.19 cubic meters for those of 100 cubic meters capacity.

This method of reflux has also made it possible for M. Claude to extract pure gases, such as neon and helium, from the air. The apparatus enables him to extract as a by-product of the industrial manufacture of oxygen and nitrogen, a mixture of nitrogen with at least 50 per cent of neon, helium, and hydrogen. To accomplish this the gaseous residues which are strongly resistant to liquefaction are drawn out, in the proportion of 6,000 liters per hour for an influx of air of 3,500 cubic meters, from the lower parts of a tubular system cooled by liquid nitrogen. By the conjunction of a pressure of four atmospheres and a very low temperature, all the liquefiable parts are condensed and the gaseous residue, if the quantity is well regulated, consists of an almost pure mixture of neon and helium.

The liquefaction of air is not the last obstacle which men of science have overcome in the field of gas condensation. Helium, which long resisted the efforts of all physicists, has finally been liquefied by M. Kammerlingh Onnes in the cryogenic laboratory at Leyden* whose installation admits of the attainment of a range of temperatures from 0 deg. down to—253 deg. C. By cooling down helium by hydrogen boiling in a vacuum and suddenly expanding the gas compressed to 100 atmospheres, the Dutch scientist has obtained a transparent colorless liquid boiling at —269 deg. C. with a density of 0.154. The critical constants of helium appear to be in the neighborhood of —268 deg. C. and three atmospheres.

Thanks to the admirable scientific equipment of the laboratory at Leyden, M. Jean Becquerel has been able to study at very low temperatures the phenomena of liquid absorption and emission, such as the magneto-optic phnomena in crystals and solidified solutions. This work of Becquerel, so important in its significance, bears on the following points:

(1) Observation of the influence of variations of temperature on the abnormal phenomena of absorption and dispersion. Laws of the variation of the width of bands, and the existence for each band of a maximum absorption. Calculation of the number of corpuscles producing absorption. Spectral analysis at low temperatures.

(2) Study, in crystals and solutions of a phenomenon of the same nature as the Zeeman effect. Invariability at varying temperatures, of period changes produced by magnetism. Observations at low temperatures of phenomena showing the variation in stability of vibrating systems, where their period is modified.

(3) Rotary magnetic polarization at low temperatures. Explanation of rotation in the vicinity of the band of absorption. Generalization of the phenomenon of rotary magnetic polarization. Extension of the phenomenon to biaxial crystals. Joinder produced by a magnetic field, of two principal vibrations, normal to the lines of force. Experimental proof of the existence in a body submitted to a field normal to a luminous ray, of a longitudinal component of electric force.

As M. d'Arsonval has so aptly pointed out in his paper at the close of the conference, the study of these phenomena gives new results on the nature, the movements, and the number of the electrons which produce absorption. It contributes to the extension of our knowledge as to the ultimate constitution of matter.

The study of the phenomenon of magnetic saturation at low temperatures permits, as M. Pierre Weiss has remarked, of the determination of the magnetic moment of the molecule.* This quantity is fundamental in the expression of the law of corresponding magnetic states, a law analogous to that of the same name which governs the compression and dilation of bodies.

A study of such importance as the molecular modification of bodies is rendered possible by the well-known fact that electric conductivity increases as the temperature is lowered. The creation of powerful magnetic fields by simple coils cooled down and traversed by very intense currents permits the realization of the atom, and allows it to be transformed and its movements modified.

For this reason the first section of the congress adopted the following resolutions presented by Messrs. Jean Perrin, Mathias, and Kammerlingh Onnes:

"(*a*) In view of the extreme importance which is attached to the modification of atoms and the possibility of attaining this result by means of an intense magnetic field (a possibility which the Zeeman phenomenon has already demonstrated), the congress offers the resolution that the nations should unite for the construction of a great electro magnet without iron, the efficiency of which shall be increased by an intense refrigeration.

"(*b*) In view of the admirable scientific equipment of the cryogenic laboratory at Leyden and the hospitable offer of welcome made by Prof. K. Onnes to the investigators of all nations, the physicists present at the first section of the Congress of Refrigeration express the following resolution: That the governments of the nations represented at the congress should furnish necessary assistance to permit physicists to carry out at the cryogenic laboratory at Leyden researches with regard to physical properties at very low temperatures.

"(*c*) The congress resolves that an international association shall be founded to further such study, scientific or otherwise, an association with its headquarters at Paris, which while aiding the already specialized fields of research shall undertake the study of the whole domain of low temperature.

"In view of the high degree of interest which attaches to the carrying out and co-ordinating of scientific research in the field of low temperatures, the congress resolves, that the bureau of section A shall be charged with the organization of a permanent international association for the study of all scientific questions relating to low temperatures."

II. REFRIGERATING MEDIA.

In the storehouses where at the present day foodstuffs are preserved by refrigeration, low temperatures are obtained by the vaporization of the following liquefied gases: Ammonia, sulphurous anhydride, carbon dioxide, and methyl chloride.

The liquefaction of these refrigerating agents may be attained (1) by means of a compression pump (compression machines); (2) by means of a solvent such as water (absorption machines). In the compression machines, which are at present the most widely used in the refrigerating industry, the gas liquefied in the condenser or liquefier, passes by way of a regulating cock into the refrigerating chamber or evaporator; there it is vaporized by a pump which draws out the vapor, compresses it, and sends it to be liquefied again in the condenser. In the absorption machines there is also a liquefier connected with a refrigerating chamber by a stopcock. The compressor —the aspirating and force pump—is replaced (*a*) partly by an absorber in which the vapors from the refrigerator (in these machines as a matter of fact ammonia gas is used) are dissolved in water; (*b*) partly by a boiler where the heated ammonia solution gives off ammonia gas. This is again condensed in the liquefier.

The utilizable effect of such a machine, or its refrigerating power, is measured by the quantity of heat absorbed in the refrigerator during a certain period, or as is sometimes said, the quantity of cold developed in the refrigerator during the same period.

As M. Barrier has remarked, this power varies widely with the temperature of the refrigerating agent at the condenser and at the refrigerator. The specification of these temperatures affords the only means of comparing with any exactitude the claims of machines made by different constructors, and the only means of avoiding difficulties in commercial contracts and exchanges.

Furthermore, different countries adopt different units to express this refrigerating power. In France and Germany they express the refrigerating capacity by the number of kilogram-calories absorbed, or kilogram-frigories (negative calories freed per hour). In England and in the United States they prefer to measure the refrigerating capacity for a day of 24 hours and express it in tons of refrigeration, but in England the refrigeration ton is equal to 81,300 kilogram-frigories while the refrigeration ton in the United States only amount to 72,600 kilogram-frigories. Lastly, moreover, in the United States the constructors and consulting engineers often express the cooling capacity of the machines in gallon degrees per minute, the temperature of the refrigerator being kept at —10 deg. F. (—23.3 deg. C.). Such a unit is equal to 110.26 hour-frigories.

It would be very useful to adopt for the refrigeration capacity, and for the different quantities which have to be considered in the refrigeration industry, a perfectly co-ordinate system of units like that used in electricity.

M. Maurice Leblanc has submitted a very carefully studied out report on this subject. But in view of the opposition of the English-speaking delegates the question does not seem to be fully settled, and Section II has passed the following resolution:

"That an international scientific commission, composed of theoretical and practical specialists in the subject of low temperatures, shall be appointed to consider values, units, and notation suitable to the refrigerating industry, and shall report at the next congress." It is to this commission that the proposition of M. Kammerlingh Onnes to give the name of Carnot to the unit of entropy, has been referred.

This same commission has been likewise charged with the duty of fixing the temperatures of condenser and refrigerator, which shall be adopted so that the refrigeration capacity of a machine may be defined. Section II has only been able to take the following resolution on that subject: That the normal capacity of a refrigerating machine shall be defined by the number of thermal units it can produce in an hour at the given temperatures of the gas at condenser and refrigerator, the choice of these temperatures and thermal units to be left to the determination of the international commission charged with the selection of units.

As a corollary to these resolutions it is likewise desirable to unify the methods of testing refrigerating machines. For this reason the following resolution has also been adopted by Section II: That the question of simple, practical, and uniform methods of testing refrigerating machines, based on the units defined by the international commission and applicable to the different types of machines and to different circumstances of installation, shall be made a subject of study, with a view to international agreement.

(To be continued.)

From the *Mineral Survey of Ceylon*, the initial stage of which may now be regarded as practically completed, it is clear that the island contains, in addition to gem stones, a number of minerals of commercial importance, of which only graphite, mica and thorianite are at present worked. The mining of graphite is on a large scale, and in some cases is under European supervision. This mineral is an important article of export. Mica is only mined to a small extent by primitive methods, but there is room for further enterprise in this material now that it is known that much of the Ceylon mica is of value for special purposes. Thorianite is a new mineral discovered as a result of the operations of the survey. Comparatively large quantities have been profitably exported in recent years and utilized in this country as a source of the thoria used in the manufacture of the incandescent gas mantle.

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* Mathias: Le Laboratoire cryogene de Leyde. Revue générale des Sciences, Paris, vol. vii, 1896, p. 381.

* P. Weiss: L'hypothèse du champ moléculaire et la propriété ferromagnetique. Revue générale des Sciences, February 15th, 1908.

Modern Deluge Sets for Fire Extinguishing Service

Heavy Streams and How They Are Handled

By Frank C. Perkins

It is the criticism of many fire experts that in the past altogether too little attention has been given to the water stream, either as regards character, body or manipulation. The chief thought has been to shorten the time required to reach the fire, which has been cut down from minutes to seconds by the introduction of modern improvements. It can not be denied that in this respect progress has been along the right lines.

But this much being accomplished, the next step should be the adoption of a system of producing and handling streams which would with equal promptness stop the fire. Our illustrations show a number of devices designed especially with this object in view, and aiming to produce a stream of great compactness and carrying power.

It is well understood that the stream of water, in order to be effective, must be increased in size and distance as nearly as possible in proportion to the extent of fire since heavy streams only are effective on large fires. Many people are not aware that such heavy streams can be produced from ordinary pressures by the employment of proper nozzles for the purpose.

Almost every fire department is equipped with chemical extinguishers and nozzles giving ordinary sizes of streams, such as are indispensable for ordinary fires, but in many cases they are not equipped for coping with the greater disasters caused by fire. While ordinary fires have been provided for, exigencies of great conflagrations, to which are due the heaviest losses in this country, have not been met.

With the latest nozzle system for producing and handling powerful streams it is possible for every fire company to have at hand at a very small expense, all sizes of streams whereby immediately to meet any conflagration with a stream of water in proportion to the size of the fire.

These modern deluge sets are very light and compact and can be put in operation at a moments notice, the 3½-inch reducers being provided with the same thread as the regulation 2½-inch hose thread in the department, so that upon reaching a fire the deluge set can be placed upon the line of hose at any point desired; the ordinary 2½-inch line of hose for inside work can then be extended to any place desired by simply turning off the deluge nozzle tip. If the firemen are driven out of the building the 2½-inch line of hose can be disconnected from the deluge line, the nozzle tip replaced and the deluge stream with all its force then projected into the fire without loss of time. With these modern deluge nozzles any section of the 2½-inch hose in the fire department can be adapted to deliver as large streams as may be profitably used on 2½-inch hose.

A special holder is provided for handling these heavy streams, taking all the weight and reaction from the man at the nozzle so that he is able to direct the stream without difficulty under pressures which

TWO-INCH STREAM FROM 150-POUND HIGH PRESSURE SERVICE

without these devices would require several strong men to control.

It will be readily seen that when firemen have at their command the means of adjusting the stream to the conditions of the fire a principle will have been adopted which will more than double the efficiency of the fire service, and which will reduce fire losses and insurance rates by the millions. In fact, this change has already in part taken place.

There has been devised a special reducer which turns directly on the male coupling of any section of hose. The construction of this reducer is such that it takes all twist and whirl from the stream and brings water friction to a minimum. The water leaves the nozzle in a straight, solid stream, which carries nearly all the water undivided to the end. A stream without solidity is deficient in carrying power and almost worthless against a strong wind.

Our accompanying full page illustration shows a 1¾-inch solid stream issuing from the improved type of nozzle in use at Manchester, New Hampshire. In the small view is seen a 2-inch stream thrown from a high pressure service of 150 pounds, the nozzle being supported upon a simple holder and platform, while two of these devices are shown in service in our last engraving, one nozzle throwing a 2½-inch solid stream from a gravity hydrant at a pressure of 85 pounds to a distance of 337 feet while the other nozzle is throwing a 1⅛-inch stream from the same hydrant.

The efficacy of the hose-holder has been amply proved. It is quite possible for a small child to direct and control the stream from a hose equipped with this holder, though the jet of water issuing therefrom be so powerful as under ordinary conditions to severely tax the strength of an able-bodied man.

By such careful attention to nozzle design and the details of hose equipment, it should be possible to do a great deal to advance the present practice of fire fighting, and to save the community much of that loss which is caused annually by the destroying flame.

ONE OF THESE NOZZLES IS THROWING A 2½-INCH STREAM TO A DISTANCE OF 337 FEET. THE OTHER IS A 1⅛-INCH NOZZLE. BOTH ARE ON AN 85-POUND HYDRANT

MODERN DELUGE SETS FOR FIRE EXTINGUISHING SERVICE

The Function of Soap in Insecticides

Some iteresting researches upon insecticides are reported upon by Messrs. Vermorel and Dantony of Paris. There are two general classes of insecticides, those which act as poisons on the food of the insect and others of the external kind which kill the insect by simple contact. It is the latter which are considered by these authors. One of the essential points to be borne in mind in the making up of such preparations is the necessity of providing for an intimate contact with the insect. In order to wet a given body in the best way a liquid must be chosen which has a low surface tension. However, the authors show that with oleate of soda (soap) the same wetting effect is produced by the addition of 5 per cent to the solution as of 0.1 per cent. The soap need not be used nearly as strong as is commonly supposed. Solutions of 1 in 1,000 are as efficient as those of 50 per 1,000. For hard water a little carbonate of soda should be added. A very cheap mixture is to use with flowers of sulphur one per cent of soap and the same amount of carbonate of soda, and we have a product which wets instantly. Thus with the usual dose (20 pounds sulphur per 100 gallons of water) the solution needs to contain but 2 in 10,000 of soap. They find that alcohol is not needed here to increase the moistening action. The major part of coleopters and grape vine insects are instantly wet with 5 per 10,000 soap solution. Insect webs are moistened by 1 in 1,000 solution.

Mirage in the Metropolis

The London *Times* publishes a letter from Mr. H. Thompson Lyon describing the occurrence in the heart of London of an optical phenomenon that one associates with burning deserts and barren plains, rather than with the streets of a great metropolis. Mr. Lyon writes:

"I witnessed this afternoon at a quarter to 3 o'clock a remarkable example of the mirage on the north side of Grosvenor Square. The whole surface of the roadway appeared a sheet of water. My first impression, before I realized what the phenomenon was, was that a water main had burst and flooded the road. On approaching closer, the water broke up into pools and then disappeared altogether. There was no one about except the policeman on duty, and he would not believe me, until he had gone up to the spot, that the road was perfectly dry. He called my attention to the disturbance of the heated layer of air by the motor cars, which exactly reproduced the effect of wheels splashing through shallow water. I have frequently seen the mirage in the desert of the Sudan, but I have never observed a more realistic exhibition. It would be interesting to learn if other instances of mirage have been observed in this country."

In reply to the query at the end of this letter, the Quarterly Journal of the Royal Meteorological Society states that a mirage was observed in London by Dr. Wollaston, F.R.S., in 1797.

In attempts at reforestation of the treeless areas of our national forests by the Forest Service it was found that on an average half of the seed was dug up and eaten or carried away by mice and chipmunks. Attempts to poison the animals, however, have proven very successful. Oatmeal mixed with strychnine and water, or wheat coated with hot tallow mixed with strychnine as a protection against rain or moisture, proved very effective. The poison should be distributed several days in advance of the seeding.

A Remarkable High Power Electric Locomotive

A 1000-Horsepower Plant on Wheels

Our illustrations present views of a very interesting electric locomotive in operation on the Wiesenthalbahn in Baden. The weight of the locomotive is 66½ tons; it measures 43½ feet in length and 10 feet in width. The adhesion weight is 42 tons. There are six driving wheels of 4 feet diameter coupled to the electric motors by connecting rods with 20-inch stroke. The smaller wheels at the leading and trailing end are 2 1/3 feet in diameter, and the total wheel base is about 30 feet, the fixed base of the drivers being 11½ feet.

The locomotive carries two 500 horse-power motors, giving a total output of 1,000 horse-power on normal load, with a maximum draw-bar pull of somewhat over 10 tons. It makes 42 miles an hour hauling a train of 12 passenger coaches with a seating capacity of 51 each (aggregate weight 230 tons) or 27 to 30 miles an hour taking 15 to 20 freight cars (500 tons). The motors are of the multipolar type, and are capable of giving 800 horse-power each in an emergency.

The power is supplied by the Rheinische Kraftwerke in Augst, at 10,000 volts and 15 alternations per second. The locomotive was built by the firm J. A. Maffei, of Munich, and is giving full satisfaction. One of the heaviest grades on the line, between Basel and Zell, figures about 1:100, and is negotiated without the slightest difficulty.

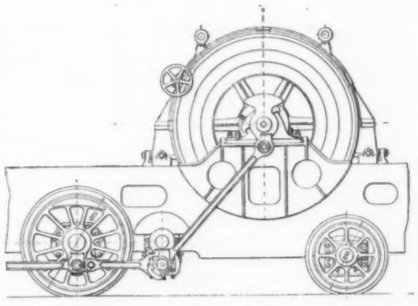

FIG. 2.—DETAIL VIEW, SHOWING COUPLING OF MOTOR TO DRIVE WHEELS

Are Time and Space Infinite?

THE question proposed above forms the subject of a discussion which has appeared in *Popular Astronomy*; in particular the affirmative answer is ably sustained by C. H. Ames, from whose plea we quote some of the most striking passages.

"Every one recognizes that a finite space implies or presupposes larger space to exist in. So, on reflection, just as truly, does its environment. As we pass from one space to another we are still in space, and all finite spaces are parts of space itself,— the all comprehensive and necessary reality which makes finite spaces possible.

"Hence, space is limited only by space, i. e. self-limited, i. e. universally extended and infinite. There is, and always must be, "space" beyond any and all "spaces," and when we say "always must be" we have the true, undeniable and perfectly satisfactory thought of the infinite. Why do we unhesitatingly say "and always must be?" This brings us to the most important distinction which it is possible for the mind to make, and the one which, when clearly perceived, will solve a vast number of knotty problems, and prove an emancipation of the mind from the unwelcome tyranny of one of our faculties which yet seems to so many persons to be unescapable.

"It is true that most of the thinking of mankind is what might be called image thinking. It may even be admitted that most of it must be of this kind, and not only accompanied by, but in a sense dependent on, the image the mind makes of imagable things.

"The question is whether there is another kind of thinking and a superior kind, which, whether *accompanied* or not by images, is not in any sense *dependent* on them for its cogency and reliability. It is certain that there is, and that even the ordinary, and perhaps not very reflective, man makes not infrequent use of it, as, for example, when he says, of a repeating decimal, "and so on forever." We say that two and two are four. We hold the terms of this statement clearly in mind, and cannot frame a doubt of its certitude. But we quite as confidently affirm that two quintillions and two quintillions are four quintillions. What are the grounds of our certitude in the second case? We realize that it is our insight into "the nature of the case." In other words, it is our direct insight into reason, on which we rely, and not at all on our power to envisage or imagine the separate units of this stupendous sum.

Moreover, we know that the truth we have so positively stated not only is true now, but we are equally sure that it always was, and always will be, true, and that we have here a regal and transcendent power of the mind of a wholly different order from that which depends on the power to create images, which, in order to *be* images, *must* have borders and limits, and must, from their very nature, be finite.

Thus we may know thoroughly the *nature* of not only the finite but also the infinite. It is the power of reason, as contrasted with that of imagination. The mind then is capable, by the insight of reason, of knowing that which the imagination, from the nature of the case, is utterly powerless to cope with. It sees the infinite is never the indefinite, but the *self*-limited, and that this is a positive and satisfactory result. The indefinite is never the infinite, though almost universally it obtrudes itself when the infinite is spoken of. The indefinite is, when seen correctly, the *not yet defined*, but that which, for all that we know, may yet sometime be defined.

But the true infinite, of which we may have any number of examples, and of which we may make constant and most important use, is never of that kind. Bearing its definition and nature constantly and unswervingly in mind, we may affirm, with utmost confidence and positiveness, that both space and time are truly infinite.

The mental protest which the imagination instantly makes is *only* the protest of the imagination, which not only *may* be but *must* be set aside as impertinent and meaningless in the light of our higher insight.

The effort of the imagination to find an end to space, or a beginning to time, may be seen from the outset to be futile. In such effort, the imagination, as Herbert Spencer truly says, "sinks exhausted," as we know it was doomed to do, and its effort is not sublime but merely tedious and foolish, and in no wise throws doubt upon the deliverance of reason or presents any dilemma in regard to it.

If one should ask the shape of space, whether spherical or otherwise, his question dissolves in absurdity when he realizes that he is thinking of space, not as infinite, as we know it must be, but as finite, a space, requiring larger space, of the old fashioned sort, to exist in, and hence he is a victim of his imagination, and can be emancipated from this tyranny only by reliance on his reason. What is true of space in this regard is equally true of time, as will be readily seen. Space and time, then, are truly and positively infinite, despite the protest of the imagination.

In the light of this thought the difficulty found with the thought of time and space disappears.

Professor Pickering has said: "If it is difficult for us to imagine infinite space, it is still more so to comprehend infinite time. As we go back eternally through the ages, how is it possible for there to be still an infinity of time before that? Yet we cannot conceive of an actual day or instant before which time did not exist."

We see that in these few lines Pickering has used the terms "imagine," "comprehend" and "conceive" as interchangeable and without difference of meaning. It is, therefore, not surprising that he is led into mental tangles in which he has recourse to such grotesque and, as Herbert Spencer says, only "verbally intelligible" expressions as those relating to time and space so "curved" that they return into themselves.

It is the contention of this article that the trouble with the notion of infinite space is but the protest of the imagination and, therefore, negligible, and that, therefore, the recourse to notions of a curved space, and even a curved time, of such nature that "if we could go back far enough into yesterday, we shall arrive at to-morrow," is as needless as it is fantastic and absurd.

■ **Dr. August Schmauss** has been appointed director of the official meteorological service of Bavaria, succeeding the late Fritz Erk.

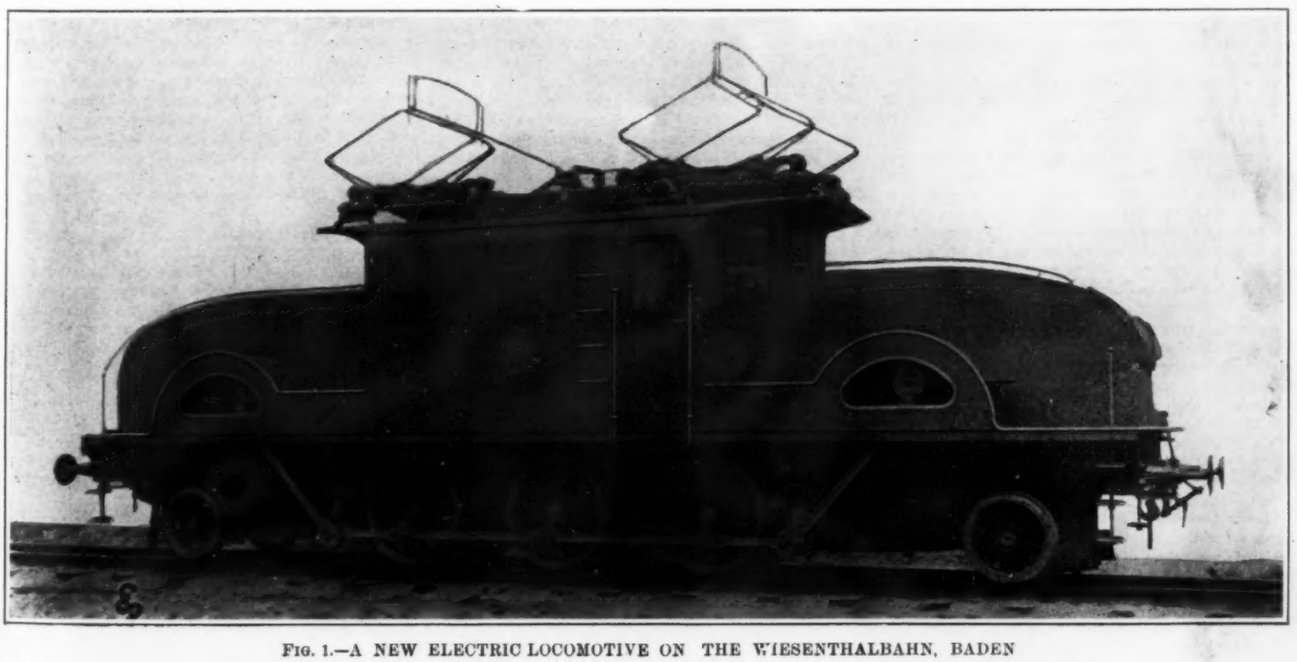

FIG. 1.—A NEW ELECTRIC LOCOMOTIVE ON THE WIESENTHALBAHN, BADEN

The American Navy*

Its Material and Its Personnel

By George von Lengerke Meyer, Secretary of the Navy

IT is not perhaps generally known that Lincoln's military activity during the Civil War included naval operations as well as military operations on land. His orders and instructions to commanders of joint expeditions required the most perfect co-operation. He did more than merely approve plans submitted to him; he originated many of them. His mind readily solved most of the war problems submitted to him, though the men and means were not always available for success.

Lincoln had the greatest confidence in the integrity of Hon. Gideon Welles, his Secretary of the Navy, and in the efficiency and ability of Captain Gustavus Vasa Fox, the Assistant Secretary of the Navy. Through the latter he maintained close relations with all naval operations.

Throughout the war Lincoln's custom was to spend a portion of every evening with Captain Fox in the telegraph office at the Navy Department, and through his relations with him and the Secretary of the Navy he was in close touch with practically every detail of naval operations of the Civil War, including all independent and co-operative movements, and he clearly defined the relations between the naval and military services as strictly co-operative, rather than subordinating one to another.

Lincoln is quoted as saying: "The Mississippi is the backbone of the Rebellion; it is the key to the whole situation; while the Confederates hold it they can obtain supplies of all kinds, and it is a barrier against our forces."

Lincoln's personal interest in Farragut's campaign was so great that when the Admiral hesitated about ascending with his ocean-going vessels, from New Orleans to Vicksburg, Lincoln sent him, through the Navy Department, imperative orders to proceed up the Mississippi to meet the fleet of the Mississippi River Flotilla from above.

His admirable judgment is evident in all his orders regarding naval affairs during his entire administration. While entirely ignorant of technical and tactical details, his power of logically arranging groups of facts gave him a clear insight, and better still, real foresight in all larger strategical questions.

In Lincoln's time the largest ship was the Niagara, a screw vessel of 6,000 tons. Her complement was 30 officers and 400 men. No gun of the type used on vessels from 1861 to 1865 fired a projectile that could penetrate the armor of the modern battleship.

The Monitor, completed in 1862, was the first step toward the modern dreadnought. The first dreadnought, launched in 1906, has a displacement of about 18,000 tons and a battery of ten 12-inch 45-caliber rifles. The battery of the Monitor consisted of two eleven-inch smooth bore guns, firing projectiles weighing 170 pounds. She had a displacement of about 1,000 tons and a draft of 12 feet. Though smaller than the Merrimack, she was of superior strength on account of her heavier guns and armored turrets. The Merrimack was of 4,600 tons displacement, covered with iron plate like a box, and had ten guns, including six nine-inch guns.

THE DREADNOUGHT TYPE CONCEIVED IN AMERICA.

It is not generally known that in the summer of 1903 the ideas of the all-big-gun ship was conceived in the American Navy and a sketch was submitted for the consideration of the officers in attendance at our War College, in Newport, R. I. This plan was discussed at the War College during that summer. In January, 1904, the General Board having considered the suggested plans, requested the Department to direct the Bureau of Construction and Repair to prepare tentative designs for a battleship with a battery of twelve heavy turret guns. The letter was referred to this Bureau by the Secretary of the Navy, with directions to prepare such design. In September of the same year the General Board asked to be informed by the Bureau of Construction and Repair how soon the tentative design would be completed, but the Bureau had been preparing plans for the South Carolina and Michigan on lines similar to those of the Connecticut, with a mixed battery. Finally in September, 1905, it proposed the all-big-gun design for these ships. In the meantime, however, England had been at work on the British battleship Dreadnought, the first of her type, which was launched in February, 1906. Had the worth of the suggestion for the Dreadnought type been appreciated, regardless of the fact that the idea originated outside of the design bureau, the United States would have had the honor, not only of producing the Monitor, but also the first Dreadnought.

To give an idea of the strength of the modern Dreadnought, I will quote from an article by Professor Hollis of Harvard, printed in the February number of the *New York Engineering Magazine*. He says: "A single one of the American battle fleet lately returned from Europe, in the hands of the Confederacy, would have destroyed the entire Northern Navy. Not a ship, or any combination of the ships then existing, could have remained on the blockade. The cost of a modern ship must therefore be contrasted with that of our entire navy in the past of only forty years ago, in order to get anything like a fair idea of what should be paid for new ships."

The enlisted force of the Navy in 1864 was about the same as it is to-day, while the number of vessels in commission was 683, with a displacement of 500,000 tons, as against 212 vessels in commission in 1910, with a displacement of 790,000 tons.

THE NAVY BEFORE AND AFTER THE CIVIL WAR.

The Navy to-day differs from that of twenty years ago not only in ships and guns but in men. Few people appreciate the fact that 96 per cent of the enlisted men to-day are American-born, representing every State in the Union. They have not been seafaring men but are young men of high intelligence, from every walk in life. As soon as they are enlisted they are sent to a training station where they are taught sanitary care, drilled in the necessary exercises pursuant to their vocation, and within three months are generally placed on a battleship or other man-of-war. Here they are developed, according to their inclinations and ability, in electricity, machinery, gunfiring, and all requirements of a modern man-of-war, to such an extent that when their enlistments expire they are a valuable asset to the country. The Navy increases their productive powers for times of peace and makes them a strong instrument for defense in time of war.

The duties of the officers have also changed materially. The battleship fleet, which is the navy, and to which the country would look in time of trouble, is composed of enormous ships which are floating power plants, full of complex machinery. Consequently, it is necessary that the officers should be versed in engineering, as well as seamanship. Roosevelt once said every officer must be a fighting engineer. To command, or to be the executive officer of one of these great moving machine shops, requires technical knowledge, executive ability, mental training, and a physical condition as nearly perfect as possible, in order to be able to stand the strain and responsibility.

One of the most far-reaching acts of our former President, Theodore Roosevelt, was to issue an order directing our battleship fleet of sixteen vessels to encircle the globe. At the time, the success of this movement was considered by many, but not by him, as problematical and hazardous. No such armada had ever attempted a similar voyage and there were many critics at home and abroad who were skeptical and opposed to it. However, it was a stupendous success, with far-reaching results. It served as a messenger of peace instead of a menace to the world. It was received with enthusiasm and cordiality everywhere. It impressed the world with the power and skillful handling of the American Navy. The American people were proud of their ships and men and pleased with the entire success of the cruise.

NAVY ORGANIZATION.

When I became Secretary of the Navy, I found an organization dating back to the year 1842, when the expenditures were about eight and one-quarter millions of dollars and the number of sailors and marines were about eleven thousand. In 1842 but 29 vessels were in commission, with a tonnage of 30,000 tons.

In 1910 we expended approximately $135,000,000 for the Navy, had 57,000 sailors and marines, 212 vessels in commission, and a tonnage of nearly 800,000 tons.

I made it a point to study the reports of former secretaries of the Navy, of Boards, of successful shop and shipbuilding organizations, and the great navies of other countries, and finally adopted in part the recommendations of a commission which had been appointed by Mr. Roosevelt. This commission was presided over by Justice Moody, and included Admiral Mahan, Judge Dayton, the late Paul Morton, Rear Admiral Luce, and Rear Admiral Folger. It was the report of this commission which the Swift Board, appointed by me, used as a basis for the reorganization which is in effect in the Navy Department at the present time. This organization is logical and successful, and the responsibility is now on Congress to make it statutory.

While I was before the Naval Committee recently arguing for two of the latest Dreadnoughts it was suggested to me by one member that, as battleships' hulls, with their steel construction, did not become unseaworthy, instead of building a 30,000-ton battleship, we might reconstruct three of our 15,000-ton battleships to take the place of the one proposed. This member did not appreciate the fact that if the same old guns were kept on the smaller ships, the larger vessel with more modern guns and better armor and more speed could choose her own distance and annihilate the smaller vessels. But even if the reconstructed vessels had the best guns and the same speed as the large modern battleship the three together could not be maneuvered with the facility that the one large one could. Thus the one large vessel could concentrate its enormous gun-fire on the smaller vessels in turn and destroy them in detail.

To reconstruct and bring up to date is a costly and unprofitable undertaking. No one would think of reconstructing a locomotive or a street car after many years of service—then why a battleship, when the result is so poor.

The fleet, if kept up to date and with the proper military efficiency, is an insurance against war. As long as our fleet is efficient and of sufficient size we can be sure that we will not have war.

The object of the present organization in our Navy is to maintain the highest military efficiency, that is, a preparedness for war on the part of the fleet.

I have aimed to establish up-to-date business methods in the Department and navy yards. The result should be economy throughout the entire naval service, with the assurance that whenever a dollar is expended full value will be received.

In order to keep track of what is expended a new system of bookkeeping has been established by which trial balances can be furnished monthly. This has not been possible heretofore. Cost accounting has been systematized so that hereafter comparisons can be made between the various yards. Stores have been consolidated from seven store accounts into one property account. The Naval Supply Fund is to be abolished and $2,700,000 is to be turned back into the Treasury for general use of the Government.

In navy yards there has been a logical division of work into the divisions of hull and machinery, a system adopted in our successful private shipbuilding plants, as well as in the English and German navies. The abolition of the Bureau of Equipment has been recommended, its duties to be divided logically among the other bureaus. Congress has, however, neglected to do this, as yet.

HOW THE NAVY DEPARTMENT CONDUCTS ITS BUSINESS.

The business of the Department has been grouped into four natural divisions, and assigned to each division is an experienced officer who acts as an aid to the Secretary of the Navy. These aids keep him informed and serve as his expert and responsible advisors. They are the Aid for Operations of the Fleet, who attends to matters never before provided for systematically; the Aid for Inspections, who carries on a systematic and thorough inspection, ashore and afloat, with the object of avoiding large expenditures on vessels which would not be a military asset after the money had been expended; the Aid for Personnel, and the Aid for Material, the last covering the material bureaus. With this organization and the hopefulness inspired by the motto now adopted, that "The Fleet is the Navy—the Navy is the Fleet," we find to-day a healthy spirit of co-ordination in the navy and a zealous aim to get efficiency as well as economy.

Competitions have been introduced in the fleet, not only in gun practice but also in the consumption of coal and the use of stores. This has resulted in a saving in expenditures and in even higher efficiency.

To give a brief idea of the improved administration of the fleet and the navy yards, the following is interesting:

The Paymaster General of the Navy on comparing the cost of administration of the navy yards for 1910 and 1909, finds that if the gross charges had borne the same ratio to the productive work in 1910 as in 1909, the gross charges would have been proportionately greater by $3,166,307.

In 1909 there were 196 vessels in commission, and in 1910, there were 212. If the cost of maintenance per ship had been as much in 1910 as it was in 1909, the expenditures afloat, it is calculated, would have been increased $4,112,321.

The gain in administrative economy and operative efficiency of the navy may be indicated by adding these sums together, showing that but for better business

* Abstracted from an address at the Lincoln Day dinner of the Republican Club of the City of New York, Monday evening, Feb. 13th, 1911.

methods, $7,278,628 more would have been spent; in other words, the operating expenses of the navy have been reduced by that amount.

During the year in which this improvement has taken place the number of ships increased about 8 per cent; the average number of ships actually in commission was increased about 11 per cent; and the displacement of vessels was increased about 9 per cent.

The power of motive machinery was increased about 16 per cent, and the average cruising speed of the fleet has increased from 10 to 12 knots, without additional consumption of coal.

Thus, greater efficiency has resulted, with more economical administration.

The indicated improvement in economical administration amounts to about 9 per cent. of the total amounts expended for running the navy yards and ships, or 6 per cent. of the total expenditures for the entire year for all purposes.

CONDUCTING THE NAVY ON A WAR BASIS.

Ships are now moved in squadrons or fleets, engaged in battle practice, maneuvering and gun firing. Everything is carried on as though war existed, or might exist at any moment. The principle being that to be prepared for war is to avert war.

Our ships are giving strict attention to self-maintenance and to keeping of vessels in repair by the enlisted men. They only go to the navy yards for docking and for large repairs.

In all these reforms and recommendations I have had the entire endorsement and hearty support of President Taft, without whose aid and sympathy little could have been accomplished. He also is very desirous and keen that we should build two battleships a year.

With the opening of the Panama Canal the importance of the Caribbean Sea as a base of future naval operations will be realized. It is the hope of the Department to have a naval base in the accessible and suitable harbor of Guantanamo, Cuba, which is some 700 miles from the canal, and capable of harboring a fleet of fifty or more men-of-war.

It is important during battle maneuvers in peace, or a period of real hostilities, that a vessel should not be called upon to return two thousand miles in order to be repaired. This can more easily and economically be done by the development of Guantanamo as a docking and repair station. I have recommended to Congress that certain useless naval bases and yards should be abolished, bringing about a saving of about a million and a half dollars annually in maintenance for these yards alone. Congress must assume the responsibility if this is not accomplished, as it requires legislative action.

It is the intention to develop Pearl Harbor, San Francisco Bay and Puget Sound, in order that, after the Panama Canal has been completed, the entire fleet may be maintained on the Pacific Coast.

PRIVATE YARDS VS. GOVERNMENT YARDS.

At the present time Congress is in the midst of a discussion as to the method under which ships should be built—whether they should be confined to an eight-hour limitation of labor, not only in the Government yards, where eight-hour labor is the rule now, but also in private yards. It is interesting to note the extra cost involved and what a detriment it would be to the resources of the country if the private yards are to be driven to an eight-hour basis just at the moment when our shipyards are successfully competing with the shipbuilding organizations of the great maritime nations. We know that if the vessels of the building program recommended by the President were to be built in the Government navy yards it would cost about $20,775,000, whereas if built under present conditions of labor in the private shipyards, without restrictions by an eight-hour law, there would be a saving of about five and one-quarter millions of dollars. The battleship Arkansas, which was launched last month at Camden, N. J., was constructed and launched at a cost of four and one-half millions, or one and one-half millions less than the limit of cost fixed by Congress. The Florida, building at the New York Navy Yard, will cost $6,400,000, and its cost will exceed that of her sister ship, the Utah (building at a private yard in Camden, N. J., and launched six months ago) by $2,450,000.

In the case of the new Texas, a thousand tons larger than the Arkansas, with the eight-hour provision, the Department was obliged to accept the one offer of $5,830,000, an advance in price over that for the Arkansas of $1,750,000, although the size had only increased a thousand tons. It is estimated that the sister ship of the new Texas (to be called the New York), which Congress provided should be built in a navy yard (which means the New York yard), cannot be built for less than $7,500,000. In other words, if Congress will permit the New York to be built at a private ship yard, a saving can be effected, based on the estimate for the Texas, even with the eight-hour limit of labor, of $1,650,000.

WHAT THE NAVY MEANS TO THE NATION.

The building of the American navy has brought about many advantageous results to the country. Before the era of the white fleet (1887) a steel ship had not been built in this country. The requirements of the Navy and the studies and aid of naval officers brought about the establishment of some of the great steel plants, which are on such a basis to-day that they are able to compete successfully with the world. The new Navy is responsible for the education, development and training of a large class of men who enter our industrial world. It has enabled a number of shipyards to exist which could not have continued but for the Navy. These yards are invaluable assets to our country and are prepared, when Congress sees fit to encourage our shipping, to build the required merchant marine for the United States, which will be a valuable adjunct to our Navy.

All of us are anxious for universal peace and there are many who feel that it can eventually be brought about by an international supreme court. We must bear in mind, however, that no court can be of any service unless its decrees can be enforced. When the nations agree to an international court, it is certain that five or six great nations will be obliged to maintain navies in order that the decrees of the court will be maintained. It will be necessary that no one of these nations shall have a greater or more powerful navy than the combined navies of the other nation members of the court. We may, therefore, feel sure that the American navy in the future, under the most favorable conditions as to peace, will have to exist. It will have to be ready to do its share in the enforcement of the decrees of this court, if established, when necessary.

With the certainty of an expanding commerce in the future; with our surplus products carried to the world's markets, and with our growing responsibilities in the region of the Panama Canal, a strong navy will be a necessity.

The Products of the Soap-nut Tree

By O. W. WILLCOX and M. J. RENTSCHLER.

ATTENTION has recently been drawn to the "Soap Nut," the fruit of a tree indigenous in India and Algiers, but recently introduced into Florida, as a source of "Saponine Extracts." This is a substance applied to various uses, *e. g.* as an addition to toilet soaps and other toilet preparations, and as a foam-producing material in carbonated beverages. It is said to be also used by chemical laundries and cloth fullers instead of soap. The material at present in most general use in this country for manufacturing saponine extracts is Panama bark (quillaya). Through the courtesy of Mr. Moulie, through whose efforts some 500,000 young soap-nut trees have been planted in the United States, we were enabled to secure a couple of pounds of the soap nuts produced by the only tree in America which has reached full maturity, and through the courtesy of Schutz & Co., of Hamburg, we received two kilograms of soap nuts, of which this firm is a large importer, its supplies being drawn from India and Algiers.

In preparing the extract, we boiled 50 grams of the chopped hulls with three successive portions of water. The three portions were united and then concentrated to about one-third of the original bulk. The solution was then cooled to below 40 deg. C. A small amount of egg albumen suspensed in water was added, the boiling resumed for a few minutes and the solution then filtered hot. The addition of the egg albumen was for the purpose of clarifying the solution, as otherwise the filtration is exceedingly difficult. At first we clarified the solution by addition of Fuller's earth, but we find the clarification by egg albumen to be a more satisfactory method. We found the yield to be 73 per cent of soluble extractive matter, confirming a previous publication of E. Walter. After the extract has been concentrated to a syrupy consistency, it may be treated with fifteen per cent by weight of alcohol, the result being a dark liquid essence of high foam-producing power. The extract so prepared gradually deposits a flocculent precipitate. It is advisable after preparing the extract to allow it to stand undisturbed for several weeks, until no more precipitate is deposited, and then filter it. The extract thus finally obtained is a brilliant liquid which does not cause turbidity when added to beverages that are to be carbonated. If desired, the soap-nut extract may be evaporated to dryness, whereby it is obtained as a light, fawn-colored powder, which dissolves easily in water.

Through the courtesy of Mr. Hills, president of the Marrowfood Co., New York, we were put in possession of two pounds of Panama bark. We made an extract therefrom in the following manner:

Fifty grams of the powdered bark was placed in each of four Erlenmeyer flasks. To the first flask was added 250 cubic centimeters of water, which was boiled for twenty minutes. The extract from this flask was poured into flask No. 2 and the boiling repeated. Flask No. 1 then received 250 cubic centimeters fresh water, boiled, and the resulting extract transferred to flask No. 2, and so on, the extract of one flask being transferred to the flask ahead, its place being taken by the weaker extract from the flask behind, the whole operation partaking somewhat of the nature of diffusion as practiced in beet sugar factories. In this way the 200 grams of bark were extracted with the minimum amount of water. It is said that some makers of Panama bark extract use 300 gallons of water to get 7 gallons of finished extract, which represents a great waste of time and steam in concentrating. The yield of dry extract from the bark was 19.5 per cent. The yield of the bark is therefore to the yield of the soap nut as 1 is to 3.8 which is quite a difference in favor of the soap nut.

We next made some experiments to determine the relative efficiency of the two extracts as foam producers. We found that the minimum amount of each required to produce a preceptible foam in distilled water was one part in a hundred thousand. To produce a sufficient amount of foam for carbonated beverages, however, it was necessary to use four parts in a hundred thousand, or 0.00025 per cent, which is an insignificant quantity.

To compare the character of the foam yielded by the two saponine-producing materials, water was placed in two stoppered cylinders of the same size, the same amount of extract added to each; then the two flasks were shaken. It was found that in comparison with the soap-nut extract the Panama bark extract gives a much coarser foam; that is, one with much larger bubbles. The soap-nut foam, is, in fact, very compact and fine grained, much more attractive in appearance than the foam produced by the Panama bark extract. Moreover, although both kinds of foam are very durable, the soap-nut foam lasts much the longer. However, this is not a very important point, since either will last long enough for all practical purposes.

We also made some attempts to determine the relative emulsifying powers of the two extracts when compared with each other and with an equal weight of dry castile soap powder. In this test, 1 gram of the substance was dissolved in 100 cubic centimeters of distilled water, the solution poured into a tall cylinder with a glass stopper; 0.2 gram of various powders, such as ferric hydroxide and barium sulphate was added, the cylinder vigorously shaken and allowed to stand. It was noted that the substance settled at practically the same rate in all three cylinders, which would indicate that the soap-nut extracts have about the same emulsifying power as soap solution. We did not, however, follow this line of experimentation sufficiently far to warrant definite conclusions.

It is interesting to note that the hulls of the soap nut are not the only product of possible value of the soap-nut tree. The nuts have a hard black seed, which is slightly smaller than a hazel nut. The shell of the nut is very hard and weighs considerably more than the kernel. If ever the soap nut become a commercially important product in Florida, the seeds being necessarily a by-product, they will have more or less value as a source of oil. We give below an analysis of the soap-nut seed made by us, and for comparison the corresponding figures for peanuts, to which, in respect of its general composition, the soap-nut seed bears a close resemblance, although the flavor and other properties are very different:

	Soap-Nut Seeds.	Peanuts.
Moisture	8.40	9.2
Ash	4.04	2.0
Oil	37.18	38.6
Protein	25.38	25.8
Crude Fiber	1.84	2.5
Carbohydrates	23.16	24.4

The soap-nut seed ash is rich in potash and contains 32.31 per cent phosphoric acid. The carbohydrates are chiefly starch, pentosans and sucrose. No reducing sugar was found. Tannin is absent. The usual reaction with guiacol and hydrogen peroxide seems to indicate the presence of considerable quantities of peroxidase. There is, however, no saccharifying enzyme present. The oil which was obtained by extraction has a bland and very agreeable taste. The seed contains one per cent of lecithin.

Soap-nut hulls of good quality can be bought in Hamburg at 7½ cents a pound, which is about the price of Panama bark. As, however, the yield of the soap-nut hulls is nearly four times as great as that of the bark, the hulls, if obtainable in sufficient quantity, should have no trouble in driving the bark out of the market.

It may be here remarked that many dispensers of carbonated beverages do not use soap-nut extract to produce foam.—*Pure Products.*

Making Money Out of Bees—I*

Keeping Bees for Pleasure and Profit

By E. F. Phillips, Ph.D., in charge of Bee Culture, Bureau of Entomology

INTRODUCTION.

BEE keeping for pleasure and profit is carried on by many thousands of people in all parts of the United States. As a rule, it is not the sole occupation. There are, however, many places where an experienced bee keeper can make a good living by devoting his entire time and attention to this line of work. It should be emphasized that it is unwise for the average individual to undertake extensive bee keeping without considerable previous experience on a small scale, since there are so many minor details which go to make up success in the work. These must be thoroughly understood before there is any hope for continued success. It is, therefore most desirable to begin on a small scale, make the bees pay for themselves and for all additional apparatus, as well as some profit, and gradually to increase as far as the local conditions or the desires of the individual permit.

Bee culture is the means of obtaining for human use a natural product which is abundant in almost all parts of the country, and which would be lost to us were it not for the honey bee. The annual production of honey and wax in the United States makes apiculture a profitable minor industry of the country. From its very nature it can never become one of the leading agricultural pursuits, but that there is abundant opportunity for its growth can not be doubted. Not only is the honey bee valuable as a producer, but it is also one of the most beneficial of insects in cross-pollinating the flowers of various economic plants.

Bee keeping is also extremely fascinating to the majority of people as a pastime, furnishing outdoor exercise as well as intimacy with an insect whose activity has been a subject of absorbing study from the earliest times. It has the advantage of being a recreation which pays its own way and often produces no mean profit.

It is a mistake, however, to paint only the bright side of the picture and leave it to the new bee keeper to discover that there is often another side. Where any financial profit is derived, bee keeping requires hard work and work at just the proper time, otherwise the surplus of honey may be diminished or lost. Few lines of work require more study to insure success. In years when the available nectar is limited, surplus honey is secured only by judicious manipulations and it is only through considerable experience and often by expensive reverses that the bee keeper is able to manipulate properly to save his crop. Anyone can produce honey in seasons of plenty, but these do not come every year in most locations and it takes a good bee keeper to make the most of poor years. When, even with the best of manipulations, the crop is a failure through lack of nectar, the bees must be fed to keep them from starvation.

Fig. 1.—A Well Arranged Apiary

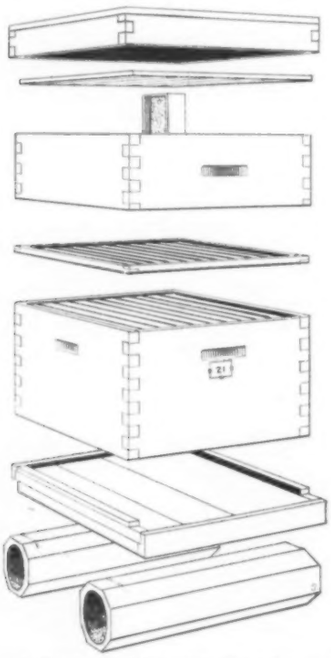

Fig. 2.—A Ten-frame Hive with Comb-honey Super and Perforated Zinc Queen Excluder

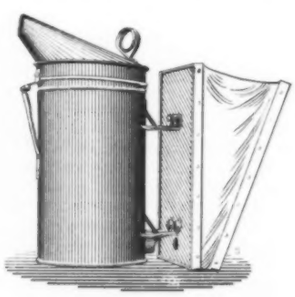

Fig. 3.—Smoker

The average annual honey yield per colony for the entire country, under good management, will probably be 25 to 30 pounds of comb honey or 40 to 50 pounds of extracted honey. The money return to be obtained from the crop depends entirely on the market and the method of selling the honey. If sold direct to the consumer, extracted honey brings from 10 to 20 cents per pound, and comb honey from 15 to 25 cents per section. If sold to dealers, the price varies from 6 to 10 cents for extracted honey and from 10 to 15 cents for comb honey. All of these estimates depend largely on the quality and neatness of the product. From the gross return must be deducted from 50 cents to $1 per colony for expenses other than labor, including foundation, sections, occasional new frames and hives, and other incidentals not, however, providing for increase.

Above all it should be emphasized that the only way to make bee keeping a profitable business is to produce only a first-class article. We can not control what the bees bring to the hive to any great extent, but by proper manipulations we can get them to produce fancy comb honey, or if extracted honey is produced it can be carefully cared for and neatly packed to appeal to the fancy trade. Too many bee keepers, in fact the majority, pay too little attention to making their goods attractive. They should recognize the fact that of two jars of honey, one in an ordinary fruit jar or tin can with a poorly printed label, and the other in a neat glass jar of artistic design with a pleasing, attractive label, the latter will bring double or more the extra cost of the better package. It is perhaps unfortunate, but nevertheless a fact, that honey sells largely on appearance, and a progressive bee keeper will appeal as strongly as possible to the eye of his customer.

Fig. 4.—Bee Veil with Silk-tulle Front

LOCATION OF THE APIARY.

The location of the hives is a matter of considerable importance. As a rule it is better for hives to face away from the prevailing wind and to be protected from high winds. In the North, a south slope is desirable. It is advisable for hives to be so placed that the sun will strike them early in the morning, so that the bees become active early in the day, and thus gain an advantage by getting the first supply of nectar. It is also advantageous to have the hives shaded during the hottest part of the day, so that the bees will not hang out in front of the hive instead of working. They should be so placed that the bees will not prove a nuisance to passers-by or disturb livestock. This latter precaution may save the bee keeper considerable trouble, for bees sometimes prove dangerous, especially to horses.

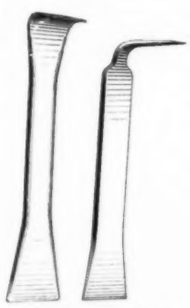

Fig. 5.—Hive Tools

The plot on which the hives are placed should be kept free from weeds, especially in front of the entrances. The hives should be far enough apart to permit of free manipulation. If hives are too close together there is danger of bees entering the wrong hive on returning, especially in the spring.

These conditions, which may be considered as ideal, need not all be followed. When necessary bees may be kept on house tops, in the back part of city lots, in the woods, or in many other places where the ideal conditions are not found. As a matter of fact, few apiaries are perfectly located; nevertheless, the location should be carefully planned, especially when a large number of colonies are kept primarily for profit.

As a rule, it is not considered best to keep more than 100 colonies in one apiary, and apiaries should be at least two miles apart. There are so many factors to be considered, however, that no general rule

* Farmer's Bulletin No. 397, United States Department of Agriculture.

can be laid down. The only way to learn how many colonies any given locality will sustain is to study the honey flora and the record of that place until the bee keeper can decide for himself the best number to be kept and where they shall be placed.

The experience of a relatively small number of good bee keepers in keeping unusually large apiaries indicates that the capabilities of the average locality are usually underestimated. The determination of the size of extensive apiaries is worthy of considerable study, for it is obviously desirable to keep bees in as few places as possible, to save time in going to

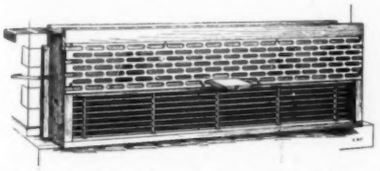

Fig. 6.—Drone and Queen Trap on Hive Entrance

them and also expense in duplicated apparatus. To the majority of bee keepers this problem is not important, for most persons keep but a small number of colonies. This is perhaps a misfortune to the industry as a whole, for with fewer apiaries of larger size under the management of careful, trained bee keepers the honey production of the country would be marvelously increased. For this reason, professional bee keepers are not favorably inclined to the making of thousands of amateurs, who often spoil a location for a honey producer and more often spoil his market by the injudicious selling of honey for less than it is worth or by putting on the market an inferior article.

Out apiaries, or those located away from the main apiary, should be so located that transportation will be as easy as possibe. The primary consideration, however, must be the available nectar supply and the number of colonies of bees already near enough to draw on the resources. The out apiary should also be near to some friendly person, so that it may be protected against deprcdation and so that the owner may be notified if anything goes wrong. It is especially desirable to have it in the partial care of some person who can hive swarms or do other similar things that may arise in an emergency. The terms under which the apiary is placed on land belonging to some one else is a matter for mutual agreement. There is no general usage in this regard.

EQUIPMENT IN APPARATUS.

It must be insisted that the only profitable way to keep bees is in hives with movable frames. The bees build their combs in these frames, which can then be manipulated by the bee keeper as necessary. The keeping of bees in boxes, hollow logs, or straw "skeps" is not profitable, is often a menace to progressive bee keepers, and should be strongly condemned. Bees in box hives (plain boxes with no frames and with combs built at the will of the bees) are too often seen in all parts of the country. The owners may obtain from them a few pounds of inferior honey a year and carelessly continue in the

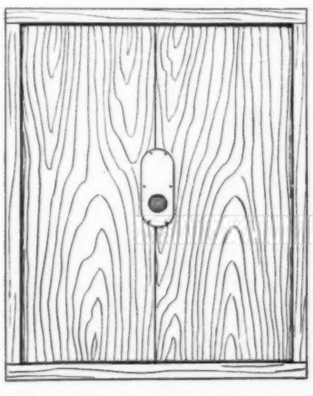

Fig. 7.—Bee Escape for Removing Bees from Supers

antiquated practice. In some cases this type of bee keeping does little harm to others, but where diseases of the brood are present the box hive is a serious nuisance and should be abolished.

HIVES.

It is not the purpose of this bulletin to advocate the use of any particular make of hive or other apparatus. Some general statements may be made, however, which may help the beginner in his choice.

The type of hive most generally used in this country (Fig. 2) was invented by Langstroth in 1851. It consists of a plain wooden box holding frames hung from a rabbet at the top and not touching the sides, top, or bottom. Hives of this type are made to hold from eight frames upward. The size of frame in general use, known as the Langstroth (or L) frame (9⅛ by 17⅝ inches), is more widely used than all others combined. The number of frames used depends on the kind of honey produced (whether comb or extracted), and on the length of honey flow and other local factors. There are other hives used which have points of superiority. These will be found discussed in the various books on bee keeping and in the catalogues of dealers in bee keepers' supplies.

Whatever hive is chosen, there are certain points of importance which should be insisted on. The material should be of the best; the parts must be accurately made, so that all frames or hives in the apiary are interchangeable. All hives should be of the same style and size; they should be as simple as it is possible to make them to facilitate operation. Simple frames diminish the amount of propolis, which will interfere with manipulation. As a rule, it is better to buy hives and frames from a manufacturer of such goods rather than to try to make them, unless one is a good wood worker.

The choice of a hive, while important, is usually given undue prominence in books on bees. In actual practice experienced bee keepers with different sizes and makes of hives under similar conditions do not find as much difference in their honey crop as one would be led to believe from the various published accounts.

HIVE STANDS.

Generally it is best to have each hive on a separate stand. The entrance should be lower than any other part of the hive. Stands of wood, bricks, tile (Fig. 2), concrete blocks, or any other convenient material will answer the purpose. The hive should be raised above the ground so that the bottom will not rot. It

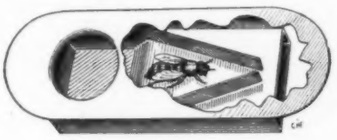

Fig. 8.—Spring Bee Escape

is usually not necessary to raise the hive more than a few inches. Where ants are a nuisance special hive stands are sometimes necessary.

OTHER APPARATUS.

In addition to the hives in which the bees are kept some other apparatus is necessary. A good smoker (Fig. 3), consisting of a tin or copper receptacle to hold burning rotten wood or other material, with a bellows attached, is indispensable. A veil of black material, preferably with a silk-tulle front (Fig. 4), should be used. Wire-cloth veils are also excellent. Even if a veil is not always used, it is desirable to have one at hand in case the bees become cross. Cloth or leather gloves are sometimes used to protect the hands, but they hinder most manipulations. Some sort of tool (Fig. 5) to pry hive covers loose and frames apart is desirable. A screw-driver will answer, but any of the tools especially for that purpose is perhaps better. Division boards, drone traps (Fig. 6), bee escapes (Figs. 7 and 8), feeders (Figs. 14, 15, 16, 17), foundation fasteners, wax extractors, bee brushes (Fig. 9), queen-rearing outfits, and apparatus for producing comb or extracted honey (Figs. 2, 18, 19), will be found described in catalogues of supplies; a full discussion of these implements would require too much space in this bulletin. A few of these things are illustrated, and their use will be evident to the bee keeper. It should be remembered that manipulation based on a knowledge of bee activity is of far greater importance than any particular style of apparatus, and in a short discussion like the present it should be given more space, especially since supply dealers will be glad to furnish whatever information is desired concerning apparatus.

EQUIPMENT IN BEES.

As stated previously, it is desirable to begin bee keeping with a small number of colonies. In purchasing these, it is usually best to obtain them near at home rather than to send to a distance, for there is considerable liability of loss in shipment. Whenever possible, it will be better to get bees already domiciled in the particular hive chosen by the bee keeper as the best, but if this is not practicable then bees in any hives or in box hives may be purchased and transferred. It is a matter of small importance

Fig. 9.—Bee Brush

what race of bees is purchased, for queens of any race may be obtained and introduced in place of the original queen, and in a short time the workers will all be of the same race as the introduced queen. This is due to the fact that during the season worker bees die rapidly, and after requeening they are replaced by the offspring of the new queen.

A most important consideration in purchasing colonies of bees is to see to it that they are free from disease. In many States and counties there are inspectors of apiaries who can be consulted on this point, but if this is not possible even a novice can tell whether or not there is anything wrong with the brood, and it is always safest to refuse hives containing dead brood.

The best time of the year to begin bee keeping is in the spring, for during the first few months of ownership the bee keeper can study the subject and learn what to do, so that he is not so likely to make a mistake which will end in loss of bees. It is usually best to buy good strong colonies with plenty of brood for that season of the year, but if this is not practicable, then smaller colonies, or nuclei, may be purchased and built up during the season. Of course, no surplus honey can be expected if all the honey gathered goes into the making of additional bees. It is desirable to get as little drone comb as possible and a good supply of honey in the colonies purchased.

The question as to what race and strain of bees is to be kept is important. If poor stock has been purchased locally, the bee keeper should send to some reliable queen breeder for good queens as a foundation for his apiary. Queens may be purchased for $1 each for "untested" to several dollars each for "selected" breeding queens. Usually it will not pay beginners to buy "selected" breeding queens, for they are not yet prepared to make the best use of such stock. "Untested" or "tested" queens are usually as good a quality as are profitable for a year or so, and there is also less danger in mailing "untested" (young) queens.

Various races of bees have been imported into the United States and among experienced bee keepers

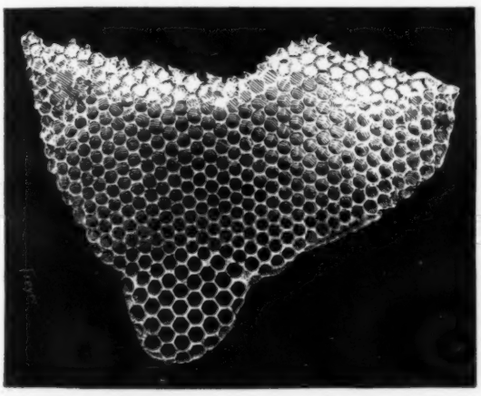

Fig. 10.—Piece of Comb, Showing Worker and Drone Cells with Irregular Transitions. Reduced

there are ardent advocates of almost all of them. The black or German race was the first imported, very early in the history of the country, and is found everywhere, but usually not entirely pure. As a rule this race is not desirable. No attention has been paid to breeding it for improvement in this country, and it is usually found in the hands of careless bee keepers. As a result, it is inferior, although it often produces beautiful comb honey.

The Italian bees, the next introduced, are the most popular race among the best bee keepers in this country, and with good reason. They are vigorous work-

ers and good honey gatherers, defend their hives well, and above all have been more carefully selected by American breeders than any other race. Especially for the last reason it is usually desirable to keep this race. That almost any other race of bees known could be bred to as high a point as the Italians, and perhaps higher, can not be doubted, but the bee keeper now gets the benefit of what has been done for this race. It should not be understood from this that the efforts at breeding have been highly successful. On the contrary, bee breeding will compare very unfavorably with the improvement of other animals or plants which have been the subject of breeding investigations.

Italian bees have been carefully selected for color by some breeders to increase the area of yellow on the abdomen, until we now have what are known as "five-banded" bees. These are very beautiful, but it can scarcely be claimed that they are improved as honey producers or in regard to gentleness. They are kept mostly by amateurs.

Some breeders have claimed to select Italians for greater length of tongue, with the object of getting a bee which could obtain the abundance of nectar from red clover. If any gain is ever made in this respect it is soon lost. The terms "red-clover bees" or long-tongued bees' are somewhat misleading, but are ordinarily used as indicating good honey producers.

Caucasian bees, recently distributed throughout the country by this Department, are the most gentle race of bees known. They are not stingless, however, as is often stated in newspapers and other periodicals. Many report them as good honey gatherers. They are more prolific than Italians and may possibly become popular. Their worst characteristic is that they gather great quantities of propolis and build burr and brace combs very freely. They are most desirable bees for the amateur or for experimental purposes.

Carniolan and Banat bees have some advocates, and are desirable in that they are gentle. Little is known of Banats in this country. Carniolans swarm excessively unless in large hives. Cyprians were formerly used somewhat, but are now rarely found pure, and are undesirable either pure or in crosses because of the fact that they sting with the least provocation and are not manageable with smoke. They are good honey gatherers, but their undesirable qualities have caused them to be discarded by American bee keepers. "Holyland," Egyptian, and Punic (Tunisian) bees have also been tried and have been universally abandoned.

BEE BEHAVIOR.

The successful manipulation of bees depends entirely on a knowledge of their habits. This is not generally recognized, and most of the literature on practical bee keeping consists of sets of rules to guide manipulations. This is, too, true of the present paper, but is due to a desire to make the bulletin short and concise. While this method usually answers, it is nevertheless faulty, in that, without a knowledge of fundamental principles of behavior, the bee keeper is unable to recognize the seemingly abnormal phases of activity, and does not know what to do under such circumstances. Rules must, of course, be based on the usual behavior. By years of association, the bee keeper almost unconsciously acquires a wide knowledge of bee behavior, and consequently is better able to solve the problems which constantly arise. However, it would save an infinite number of mistakes and would add greatly to the interest of the work if more time were expended on a study of behavior; then the knowledge gained can be applied to practical manipulation.

A colony of bees consists normally of one queen bee, the mother of the colony, and thousands of sexually undeveloped females called workers, which normally lay no eggs, but gather the stores, keep the hive clean, feed the young, and do the other work of the hive. During part of the year there are also present some hundreds of males or drones (often removed or restricted in numbers by the bee keeper) whose only service is to mate with young queens. These three types are easily recognized, even by a novice. In nature the colony lives in a hollow tree or other cavity, but under manipulation thrives in the artificial hives provided. The combs which form their abode are composed of wax secreted by the workers. The hexagonal cells of the two vertical layers constituting each comb have interplaced ends on a common septum. In the cells of these combs are reared the developing bees, and here are stored honey and pollen for food.

The cells built naturally are not all of the same size, those used in rearing worker bees being about one-fifth of an inch across, and those used in rearing drones and in storing honey about one-fourth of an inch across (Fig. 10). The storage cells are more irregular, and generally curve upward at the outer end. Under manipulation, the size of the cells is controlled by the bee keeper by the use of comb foundation—sheets of pure beeswax on which are impressed the bases of cells and on which the bees build the side walls.

In the North, when the activity of the spring begins, the normal colony consists of the queen and some thousands of workers. As the workers bring in early pollen honey, the queen begins to lay eggs in the worker cells. These in time develop into white larvæ, which grow to fill the cells. They are then capped over and transform gradually into adult worker bees. As the weather grows warmer, and the colony increases in size by the emergence of the developing bees, the quantity of brood is increased. The workers continue to bring in pollen, and nectar to be made into honey. After a time the queen begins to lay eggs in the larger cells, and these develop into drones or males.

Continued increase of the colony would result in the formation of enormous colonies, and unless some division takes place no increase in the number of colonies will result. Finally, however, the workers begin to build queen cells over certain female larvæ. These are larger than any other cells in the hive and hang on the comb vertically. In size and shape they may be likened to a peanut and are also rough on the outside. When the larvæ in these cells have grown to full size they too are sealed up, and the colony is then ready for swarming.

Swarming consists of the exit from the hive of the original queen with part of the workers. They leave the hive to seek a new home and begin the building of combs, storing of honey and pollen, and rearing of brood in a new location. They leave behind the honey stores, except such as they can carry in their honey stomachs, and the brood, some workers, and no adult queen, but several queen cells from which will later emerge young queens. By this interesting process the original colony is divided into two.

The swarm finds a new location either in a hollow tree or, if cared for by the bee keeper, in a hive. The workers build new combs, the queen begins laying, and in a short time the colony is again in normal condition.

The colony on the old stand (parent colony) has the advantage of the bees which emerge from the brood. After a time (usually about nine days), the queens in their cells are ready to emerge. If the colony is only moderately strong the first queen to emerge is allowed by the workers to tear down the other queen cells and kill the queens not yet emerged, but if a "second swarm" is to be given off, the queen cells are protected.

If the weather permits, after from five to eight days the young queen flies from the hive to mate with a drone. Mating usually occurs but once during the life of the queen and always takes place on the wing. In this single mating she receives enough spermatozoa to last throughout her life. She returns to the hive after mating, and in about two days begins egg laying. The queen never leaves the hive except at mating time or with a swarm, and her sole duty in the colony is to lay eggs to keep up the population.

When the flowers are in bloom which furnish most nectar, the bees usually gather more honey than they need for their own use, and this the bee keeper can safely remove. They continue the collection of honey and other activities until cold weather comes on in the fall, when brood rearing ceases; they then become relatively quiet, remaining in the hive all winter, except for short flights on warm days. When the main honey flow is over, the drones are usually driven from the hive. By that time the virgin queens have been mated and drones are of no further use. They are not usually stung to death, but are merely carried or driven from the hive by the workers and starve. A colony of bees which for any reason is without a queen does not expel the drones.

Many abnormal conditions may arise in the activity of a colony, and it is therefore necessary for the bee keeper to understand most of these, so that when they occur he may overcome them. If a virgin queen is prevented from mating she generally dies, but occasionally begins to lay eggs after about four weeks. In this event, however, all of the eggs which develop become males. Such a queen is commonly called a "drone-layer."

If the virgin queen is lost while on her flight or the colony at any other time is left queenless without means of rearing additional queens, it sometimes happens that some of the workers begin to lay eggs. These eggs also develop only into drones.

It also happens at times that when a queen becomes old her supply of spermatozoa is exhausted, at which time her eggs also develop only into drones. These facts are the basis of the theory that the drone of the bee is developed from an unfertilized egg or is parthenogenetic. A full discussion of this point is impossible at this time.

The work of the hive is very nicely apportioned among the inmates, so that there is little lost effort. As has been stated, the rearing of young is accomplished by having one individual to lay eggs and numerous other (immature females) to care for the larvæ. In like manner all work of the colony is apportioned. In general, it may be stated that all inside work—wax building, care of brood, and cleaning—is done by the younger workers, those less than seventeen days old, while the outside work of collecting pollen and nectar to be made into honey is done by the older workers. This plan may be changed by special conditions. For example, if the colony has been queenless for a time and a queen is then given, old workers may begin the inside work of feeding larvæ and these may also secrete wax. Or, if the old workers are all removed, the younger bees may begin outside work. As a rule, however, the general plan of division of labor according to age is followed rather closely. (To be continued.)

Physical Anomalies of Water

WATER is a paradoxical and unique substance. A thermometer filled with water, instead of mercury or alcohol, gives reliable indications of moderate temperatures, but when it is cooled below 4 deg. C. (about 39 deg. F.), it ceases to fall and begins to rise, and at the freezing point (0 deg. C., or 32 deg. F.), it stands at the same height as at 8 deg. C. (about 46½ deg. F.). In other words, water attains its maximum density at 4 deg. C., and when it is cooled below this point it expands, instead of contracting. In the act of freezing another and a sudden expansion takes place, which is the opposite of what occurs in the solidification of most substances. Hence ice floats on water, a fact of immense geological and biological importance, which prevents lakes and streams from freezing solid and preserves the animal and vegetable organisms which they contain. In all latitudes and at all seasons the temperature at great depths in the ocean is approximately 4 deg. C.

The compressibility, viscosity and specific heat of water exhibit corresponding anomalies, all of which have been attributed by Roentgen to a common cause. Roentgen assumed that water, even at ordinary temperatures, contains a variable number of polymonized or agglutinated molecules, probably identical with the molecules of ice, or that water may be regarded as a solution of ice, as syrup is a solution of sugar. The number of these complex molecules diminishes as the temperature rises.

This view is supported by the measurements of Ramsay and Shields, who account for the peculiar properties of water by the presence of associated molecules.

A note in *Cosmos* states that Duclaux, from his recent study of this theory, concludes, in agreement with Sutherland, that the molecule of ice is probably found by the combination of three molecules of water, or that the molecular weight of ice is 54 and its chemical formula is $(H_2O)_3$.

Destruction of Concrete by Hydrogen Sulphide

THE rapid disintegration of the concrete walls of sewage basins has often been observed. The German journal, *Beton und Eisen*, give an account of Stephan's investigation of the deterioration observed in the concrete vaulted roof of a sewage sedmentation basin. As the crude sewage smelled strongly of hydrogen sulphide, while none of this gas was found either in the clarified sewage or in the air beneath the vault, Stephan concluded that the hydrogen sulphide disengaged by the sewage was entirely absorbed by the concrete and was the cause of the observed corrosion.

Hydrogen sulphide can destroy concrete by combining with its lime to form calcium sulphide, which may then be converted into soluble calcium bisulphide or oxidized to soluble calcium sulphate. The analysis of specimens of the concrete of the vault confirmed these conclusions, but showed, also, that part of the drainage was due to the presence of carbon dioxide and the consequent formation of soluble calcium bicarbonate.

Stephan suggests a very simple method of preventing corrosion by coating with tar, after the concrete has hardened, all parts of the wall that are exposed to the contact of injurious gases.

The Railophone

THE various systems which have been devised for telephoning to and from moving railway trains have, as a rule, proved unsatisfactory. A new system, invented by Von Kramer, and bearing the queer name "railophone," has been employed with success on the line connecting London with Brighton. A large coil of wire is placed on the roof of the car, with its plane vertical and parallel to the rails, and its ends are connected to a telephone receiver installed in a soundproof cabinet inside the car. This coil is inductively affected by a fixed circuit, composed of an overhead telegraph wire and a cable buried beside the rail, and connected with a telephone transmitter at a station. A circuit of this kind is provided for each track.

INDEX OF INVENTIONS

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[See note at end of list about copies of these patents.]

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A printed copy of the specification and drawing of any patent in the foregoing list, or any patent in print issued since October 4th, 1859, will be furnished from this office for 10 cents, provided the name and number of the patent desired and the date be given. Address Munn & Co., Inc., 361 Broadway, New York.

Canadian patents may now be obtained by the inventors for any of the inventions named in the foregoing list. For terms and further particulars address Munn & Co., Inc., 361 Broadway, New York.

How Sea Water Freezes

ARCTOWSKI has made a series of interesting observations of the congelation of sea water. By lying down beside a hole cut in the ice formed on sea water, he was enabled to view at short range the formation of new ice close to the wall of ice surrounding the hole. At the surface of the water thin hexagonal plates of ice gradually developed in delicate fern-like forms, and grew by attracting to themselves minute crystals which formed spontaneously in the moving water. The formation of these crystals increased the density of portions of the water, so that the liquid filaments of different densities were made visible by refraction, as in a non-homogeneous mixture of alcohol and water. The floating hexagonal plates attained diameters ranging from ¾ inch to 1½ inches, and grouped themselves together irregularly, leaving interstices usually of triangular form.

At a depth of 6 or 8 inches below the surface of the water leaf-like forms from 4 to 10 inches long and with serrated edges subsequently grew from the ice surrounding the hole. The planes of these leaves were usually vertical and their axes horizontal.

The quantity of salt in sea-water ice is variable. One specimen contained 2 parts in 10,000, while the water in the vicinity contained 323 parts in 10,000. Another specimen showed 114 parts in 10,000, but when some of the same ice was partially melted very slowly, the remaining portion was found to contain only 46 parts of salt in 10,000.

State Report on Oil and Gas Development in Tennessee

By GEORGE H. ASHLEY, State Geologist.

THE State Geological Survey has just gotten out a report on the development of the oil and gas industry in Tennessee. The report, which is short and preliminary in nature, is by Mr. M. J. Munn, oil and gas expert of the United States Geological Survey, and describes the result of work done by him last summer, in co-operation with the State Survey. It describes the early finding of oil and gas in Overton and Fentress counties, the striking of gushers there, the decline of fields, and the abandonment of many of them. Then the counties of middle and west Tennessee are taken up in order, and the developments of each described. The report does not go at length into the geology of the oil and gas deposits of the State, that being left to a fuller report which it is planned to prepare within the next one or two years.

In the final chapter Mr. Munn discusses the future possibilities of Tennessee as an oil and gas State. Long experience has indicated that the Great Valley of Tennessee lying east of the Cumberlands is not an oil and gas territory, as drilling from Pennsylvania to Alabama in that belt has universally resulted in commercial failures. He also condemns the rocks of the middle basin of Tennessee as probably non-oil producing, based simply upon the fact that the rocks occurring in the center of that basin are lower stratigraphically than any rocks that have yet produced oil in commercial quantities. While this is only negative evidence, yet in view of the large number of wells, which have been drilled in rocks of that age so far without result, the evidence is not encouraging. The Cumberland Plateau, Mr. Munn considers much more hopeful and especially the western edge and possibly also the Highland Rim region between the central basin and the Cumberlands. The Highland Rim region in the western part of middle Tennessee is also considered to be possibly an oil and gas territory.

In west Tennessee no commercial oil or gas has yet been obtained, but the conditions are considered as hopeful, especially along the crest of the divide between the Tennessee-Mississippi rivers.

In general Mr. Munn finds that Tennessee is producing no oil and gas to-day in commercial quantities beyond a few wells that hardly pay interest on their investments. In a few cases gas wells are supplying one or two houses with gas or form the source of gas being burned in flambeau. Of the large number of wells drilled in this State, the great majority have been "dry holes," or unproductive. Nearly all of these holes, however, report "shows" of oil or gas, suggesting that there may be a large quantity of those substances in the rocks. A study of the situation suggests that the difficulty is the lack of porous rock or rocks that may serve as reservoirs. In practically all of the oil fields, the oil and gas is found in porous sandstones and limestones, the pores being large enough to allow the ready flow of oil or gas. This being, of course, only one of the conditions under which a flow is obtained, and as far as can be ascertained over much of this State, rocks of that character so situated as to hold oil or gas are lacking. In the case of the past oil and gas production in the Cumberlands most of it appears to have come from crevices in a limestone near the surface.

In an appendix the State Geologist discusses results of recent drilling in West Tennessee. He compares the conditions there with those in Louisiana and Texas, where oil and gas have been found, and concludes that while no oil and gas have been found in West Tennessee, and while the peculiar salt dome conditions existing in Louisiana and Texas, which have produced most of the gushers of those States, probably do not exist in Tennessee, yet that it is possible or probable that some oil and gas may be found there, but that it may require the drilling of nine or ninety-nine "dry wells" before one producing well is found; that the search for oil and gas in West Tennessee at the present stage of the game is only a gamble, in which no one should play, who cannot afford to lose and lose heavily without feeling it, in the prospect of ultimately striking oil and recovering all that they have expended and then some.

The students of the School of Engineering at the Pennsylvania State College are erecting a wireless telegraph station designed for communication with the stations at Washington, New York, Philadelphia, Boston and elsewhere. Among the uses which will be made of the apparatus, reporting football matches played by the college team in other cities where suitable wireless telegraphic equipments have been erected, may be mentioned. A level circular track, 200 feet in diameter, for making tests upon aeroplanes and propellers, has also been erected. A car driven by an electric motor will run upon this track at speeds up to 60 miles per hour. To this car will be attached the planes or propellers to be tested. The frictional resistance or lifting power of the planes and the propelling force and efficiency of propellers, will be determined by a series of dynamometers, recording the results obtained by electrical means on instruments placed upon a platform at the center of the circular track. The problem of plane shape and surface can be readily studied by this apparatus, as can also data relating to the shape, size and speed of the propellers.

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